

PIPEFITTING: SKILLS DEFICIENCIES IN METAL FABRICATION AND WELDING (PIPEFITTING) IN AUSTRALIA



Karen O'Reilly

National Overseas Fellowship

Fellowship funded by the
Department of Education, Science and Training
Commonwealth Government



Southland Industries Pipe Fitting Chiller Room project



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Abbreviations and Acronyms

AMWU	Australian Manufacturing Workers Union
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CWB	Canadian Welding Bureau
DEST	Department of Education Science and Training
EWP	Elevated Work Platform
HVAC	Heating ventilation and air conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
IIW	International Institute of Welding
ISS	International Specialised Skills Institute
JATC	Joint Apprentice and Journeyman Training Committee
LU	Local Union
MIG	Metal Inert Gas or Gas Metal Arc Welding
MCAA	Mechanical Contractors Association of America
MMAW	Manual Metal Arc Welding or Arc Welding
NITC	National Inspection Testing & Certification
NCPWB	National Certified Pipe Welding Bureau
PIPE	Piping Industry Progress & Education Trust Fund
PPE	Personal Protective Equipment
RTO	Registered Training Organisation
TAFE	Technical and Further Education
TIG	Tungsten Inert Gas or Gas Tungsten Arc Welding
UA	The United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry
VET	Vocational Education and Training
WRP	Welder Recruitment Program
WTIA	Welding Technology Institute of Australia

Abstract

This report discusses the National ISS Institute Overseas Fellowship study into the trade skills deficiencies of Metal Fabrication and Welding (pipefitting). This study was carried out between December 2005 and December 2006, and the overseas component of the Fellowship was conducted in the USA and Canada during August 2006. Pipefitting is a well-established engineering trade in North America, but virtually unknown here in Australia. Investigations into the trade of Pipefitting have been carried out and conclusions have been drawn. It is recommended that the engineering trade of *Pipefitting* as well as *problem solving and technical innovation* educational studies are introduced into the Australian engineering curriculum in an effort to resolve present trade skills deficiencies and prepare engineering tradespeople for the future innovation economy.

Outline of the Report

Chapter 1 acknowledges all those who have advised and assisted O'Reilly in this research

Chapter 2 provides a background overview to the research

Chapter 3 describes the skills deficiencies in Pipe Metal Fabrication and Welding (pipefitting) in Australia

Chapter 4 outlines the ISS Fellowship overseas program, and provides the findings of research and observations on the training facilities for Pipe Fitters in USA and Canada

Chapter 5 gives the findings on creativity and innovation in USA and Canada.

Chapter 6 proposes recommendations

1. Acknowledgements

1.1 Support

Awarding body - ISS Institute

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Fellowship sponsor

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Box Hill Institute of Technology
Skilled Engineering

Academic Support

School of Educational Studies La Trobe University
Dr Damon Cartledge and Dr Ruth Shrensky

Participants

I met with the following people during my Fellowship trip, all of whom I wish to thank for sharing their expert knowledge and passion:

Phil Campbell	Training Specialist & United Association Pipe Trades Joint Apprentices and Journeymen Training Committee for Southern Nevada LU 525
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Michael P Arndt	Director of Training United Association Washington DC
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Anne A. St. Eloi	Special Representative United Association Washington DC

	Pipe Fitter/Plumber Journeyworker
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Ricardo Nascimento	Pipe Trades Trainer United Association LU 488 Alberta Canada
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Craig Stevenson	Senior Lecturer Plumbing Reid Kerr College Scotland

1.2 Additional Support

These people have assisted me to make the most of this Fellowship, to deepen my awareness of the possibilities concerning Pipefitting in Education and Industry.

Person	Organisation
Carolynne Bourne AM	International Specialised Skills Institute
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Charlie Hatz	HSP Welding and Installation
Jay Peters	World Plumbing Council
Sylvan Tieger	World Plumbing Council

Special thanks to my parents, Kevin and Jill O'Reilly for their support.

1.3 International Specialised Skills (ISS) Institute

Over twenty years ago Carolynne Bourne AM recognised the need to work holistically across occupations and industry sectors and build bridges along the way - filling skill deficiencies and skill shortages; valuing the trades as equal, but different to professional disciplines; using 'design' (problem solving) as a critical factor in all aspects of work; working in collaboration and enhancing communication (trades and professional); learning from the past and other contemporary cultures, then transposing those skills, knowledge and insights, where appropriate, into today's businesses.

In 1990 she met Sir James Gobbo AC, CVO who was seeking to address a critical need in Australia, namely the retention and enhancement of skills and knowledge of artisans and tradesmen and joined Sir James as the founding CEO of International Specialised Skills Institute (ISS Institute).

ISS Institute has successfully functioned as an independent, national organisation, committed to identifying skill deficiencies through market research and meeting associated need through its 'Overseas Skill Acquisition Plan (Fellowship Program)', education and training activities and consultancy services.

Based on experience and acute insights gained over nearly two decades, ISS Institute has developed extensive expertise in the development of the knowledge economy encompassing high level skills and knowledge underpinned by design and innovation across industries and their related occupations.

ISS Institute has an extensive record in assisting Government and non-Government organisations, firms, industry bodies, professional associations and education and training institutions to identify skills deficiencies and deliver practical solutions.

ISS Institute has been integral to the success of organisations and individuals seeking solutions with regard to optimising and enhancing existing abilities and establishing new directions and strategies for workplace practices.

A key initiative of ISS Institute is the 'Overseas Skills Acquisition Plan (Fellowship Program)'. The ISS Institute Fellowships are an exciting and unique opportunity for Australians to enhance their capabilities.

The Fellowship Program is the means by which skill and knowledge gaps are identified and verified, and then matched to overseas organisations where the skills can be acquired. Australians are presented with an opportunity to travel overseas, or for experts to travel to Australia. Importantly, Fellows must pass on what they have learnt through their Report and participate in a range of education and training activities and events such as workshops, lectures, seminars, forums, exhibitions and conferences.

The activities place these capabilities, plus insights (attitudinal change), into the minds and hands of those that use them - trades and professional people alike - the multiplier effect.

Individuals gain; industry and businesses gain; the Australian community gains economically.

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1.4 The Department of Education, Science and Training, Commonwealth Government

The Department of Education Science and Training (hereafter DEST) provides national leadership and works in collaboration with the States and Territories, industry, other agencies and the community in support of the Government's objectives. DEST develops and implement policies to ensure the continuing relevance of education, science and training to contemporary needs and the growing requirement for lifelong learning. DEST also ensures high quality and value for money in delivering Government funded programs.

1.5 Australian organisations impacted by the Metal and Fabrication (Pipefitting) Industry

Some of the Australian industries and organisations that are impacted by Pipefitting skills include:

Manufacturing and Construction Companies: Skilled Engineering, Transfield, A J Mayr Engineering, John Holland Construction, Leighton Industries, John Beaver Engineering, HSP Welding and Installation, Onesteel, Smorgon, Bluescope Steel, Philmac, Stainless Pipe and Fittings Australia, Mathew Davis Australia, Gasweld, Fuelquip, Gilbarco, Metric, Transfield, Rulway, Apollo Engineering, Inducta Bend, HSP Welding and Installation,

Weldsure, Firequip, CM Manufacturing, TFG Foodline Stainless, Thiess, Alltype Engineering Services, Bechtel Australia, Halliday Engineering, Kolmark, Ottoway Engineering, Ackroyd Engineering Services, Danum Engineering, Gasco Australia.

Defence Industries: Royal Australian Navy, Tenix Shipbuilding, and Department of Defense, Australian Defense Industries Limited, Australian Marine Technologies, and Thales Australia.

Food and Beverage Industries: Fosters Group, Kraft, Golden Circle, And National Foods.

Petro-chemical: Shell Oil Refineries, Caltex, BASF, Orica, Qenos, Mobil, Exxon, Woodside, Kwinana, BP Refinery, Lytton, Ampol Refineries, Santos, Monsanto.

Government bodies: Department of Education Science and Training, Ministerial Council for Vocational and Technical Education, National Centre for Vocational Education Research, Department of Primary Industries, Office of Energy Western Australia, National Gas Pipelines Advisory Committee, Council of Australian Governments, Ministerial Council on Energy.

Education: Technical and Further Education, Welding Technology Institute of Australia, Australian Technical Colleges, Vocational Education, and Registered Training Organisations.

Associations: Australian Pipeline Industry Association, Australian Stainless Steel Development Association, Australian Steel Institute, Energy Supply Association of Australia, and Master Plumbers and Mechanical Services Association of Australia.

Trade Unions: Manufacturing Worker's Union, Plumbing Trades Employees Union, Australian Workers Union, and Construction Forestry Mining Energy Union.

1.6 About the Fellow

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Member of La Trobe University Alumni

Member of International Specialised Skills Institute

Member of Australasian Performing Rights Association

Over a career of 17 years, O'Reilly has worked as a trade qualified Metal Fabricator and Welder in the construction, manufacturing, maintenance and (more recently) education industries of Victoria. O'Reilly is also an artist and inventor and these combined areas of interest have been integrated throughout her career into an holistic approach encompassing knowledge, skills and insights across trades and professional fields. The culmination of these talents has provided her with a unique approach to technical innovation, problem finding and problem solving: utilising both logical and lateral thinking processes.

O'Reilly is currently employed by Victoria University, Box Hill Institute of Technology and Swinburne TAFE as an Engineering, Metal Fabrication and Welding teacher. O'Reilly is presently responsible for developing and implementing curriculum for Civil and Mechanical Engineering Diploma students as well as teaching apprentices at Swinburne TAFE Wantirna, and Victorian University.

Additional interests include travel, study, reading, writing, history, art, painting, design, inventing and craftwork.

2. Background

2.1 The Australian Context

Presently in Australia, aspects of various Pipe Trade professions are ill-defined and subject to jurisdictional confusion. Although we have pipe trade workers such as Plumbers and Gas Fitters, Australia, unlike the USA and Canada, has never introduced the trade of Pipefitting. It is unclear as to why this situation eventuated. However, it is probable that it is a legacy of the changing nature of industry and the role of the Boilermaker.

During the reign of steam power, the Boilermaker's duties included the fabrication, installation and welding of industrial pressurised steam pipes. As times changed, so too did the scope of a Boilermaker's job – steel pipe fabrication, once a large part of the Boilermaker's occupation, for whatever reason eventually faded into obsolescence from apprenticeship training. During the 1990s, even the trade title changed: A *Boilermaker* became a *Metal Fabricator*. Although pipe work was removed from the Fabrication curriculum, industry continued to demand workers with highly developed metal pipe fabrication and welding skills. Without means to acquire pipe fabrication training, Australian industry, through necessity, has created an unofficial Boilermaker/Fabricator 'sub-trade' of Pipe Fitter/Welders. Although Boilermakers/Fabricators have highly developed metal engineering trade skills, they generally have very little specific knowledge about pipe engineering, fabrication, installation, design, troubleshooting or piping maintenance considerations. In the USA, a Pipe Fitter must complete a 5-year apprenticeship (minimum). This in itself paints a fairly clear picture of the Australian skill-deficiency by comparison.

Presently in Australia, the two national codes that border the trade of Pipefitting are:

1. Certificate III Metal Fabrication MEM 30305
2. Certificate III Plumbing BCP 30103

There is great potential for the engineering trade of Pipefitting to be introduced into Australia.

2.2 Purpose of the National ISS Institute Overseas Fellowship (hereafter, the Fellowship)

It is the purpose of this Fellowship to undertake an overseas study program to gain a comprehensive understanding of Pipefitting and design, creativity, problem solving and innovation in engineering trades.

2.3 Background to the Report

O'Reilly (ISS Fellow, researcher and author of this report) is an Australian Metal Fabricator and Welder with 17 years industrial experience working for various manufacturing and construction companies in and around Melbourne, such as Tenix Defense Systems and Skilled Engineering. Required to perform the duties of a Pipe Fitter without access to appropriate pipe training, and realizing the difficulties involved sourcing information pertinent to the fabrication, welding, design and installation of metal pipes for industry, it soon became evident to her that Pipefitting was a skills deficiency in need of addressing. Although still working in industry at the time of receiving the ISS Fellowship, O'Reilly presently works as a VET Metal Fabrication and Welding teacher for Box Hill Institute and Swinburne TAFE and is also completing a Masters of Education degree at La Trobe University Bundoora.

The main purpose of this report is to identify the problems and issues associated with the lack of Pipefitting skills training in Australia and through experience gained on the overseas study suggest an approach to solving these. At present, there are many problems and issues regarding the training of Pipefitting skills in Australia including:

- **Health and Safety:** Presently there are risks associated with an unskilled workforce designing and installing dangerous fuel pipes, process piping, high-pressure steam piping, food grade piping and other industrial piping systems.
- **Employment:** Tradespeople with Pipefitting skills are highly valuable to industry owing to their scarce numbers. An increased number of workers with Pipefitting skills would benefit Australian industry.
- **Education:** The implementation of a curriculum incorporating Pipefitting skills would improve the quality of content and training within our Technical Educational institutions. O'Reilly's Fellowship took her to North America where she met with industry professionals and organisations that specialise in the trade of Pipefitting.

2.4 Design, Creativity, Innovation and Problem Solving in Pipefitting

At present, neither Australian curriculum designers nor engineering based technical educational institutions, include in their training a teaching method or program that deliberately encourages the development of skills such as design, creativity, innovation and problem solving. It is an unfortunate reality that competency based training modules (currently employed by trade/apprenticeship institutions) are not designed to acknowledge and accommodate the development of practical problem solving and creativity skills that are so heavily rely in the engineering field. Every day, trades people are required to find ways to fix things, design functional parts, solve mechanical problems and invent mechanisms – taking into consideration any number of variables such as: environment, safety, functionality, cost, personal ability and physicality, time, access to equipment and materials – because this is what they are employed to do. The ability to solve complex and abstract technical problems is the measure of a good tradesperson.

Design, creativity and problem solving skills are integral to the Pipefitting trade as Fitters must be able to negotiate ever-changing functional design factors from site to site.

A workforce equipped with these skills would benefit:

- **Health and Safety:** Improvements in trade people's capacity to negotiate design factors on the job would have far reaching implications regarding improvements to health and safety in the workplace.
- **Quality of training:** Australian educational institutions would gain greater relevance, authority and respect from industry when their training programs are fine-tuned to align with present day *innovative* engineering practice.
- **Industry:** The Australian engineering industry already depends heavily on the design, creativity, innovation and problem solving skills of its tradespeople. Industry would benefit further from a smarter, more innovative workforce.

2.5 Aim of the Fellowship

This Fellowship report aims to:

- outline present engineering skills deficiencies in Australia related to pipefitting
- investigate and document how these skills are implemented and achieved in other countries such as USA and Canada
- research best practice in North America, including Canada
- create and maintain international networks with relevant pipefitting organisations overseas
- overcome the current knowledge and skills deficiencies embodied within the field of pipefitting
- Overcome the current knowledge and skills deficiencies of *problem solving and innovation* in engineering trade education
- address these deficiencies in order to create a better and more efficient engineering, construction and manufacturing industry in which costs and sustainability issues can be addressed
- provide suggestions and recommendations as to how this may be achieved.

3. Deficiencies in Pipefitting Skills

Skills deficiency – definition

A skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas. This is the key area targeted by the ISS Institute.

3.1 The skills and knowledge gaps

In the engineering industry, tradespeople with Metal Fabrication, Boilermaking and Welding qualifications, are also often required to perform the work of a *pipe fitter*. Although there is indeed no institution in Australia that teaches the trade knowledge required by the role, it does not deter companies from advertising in the employment columns to fill *Pipe Fitter Wanted* positions. Western Metropolitan College of TAFE (now Victoria University) once trained AMECON (now *Tenix* shipbuilding) apprentices, and developed a few modules to assist these apprentices acquire basic pipefitting skills. As an apprentice at that time herself, O'Reilly volunteered to undertake these modules as she was already performing the duties of a pipe fitter on site – responsible for the design, construction and installation of stainless steel piping for beer production at Carlton United Breweries in Abbotsford, Victoria. Although these modules were of some assistance, most employed in these positions still relied on information from old boilermaker tradesmen, old books (with imperial measurements) and the old '*suck it and see*' approach. Following this, O'Reilly went on to work for Tenix Defense Systems as a Ship Builder, Pipe Fitter and Welder at the Williamstown Shipyards between 1998-2000.

Tradespeople with pipefitting skills are highly prized in Australian industry because of their rare and specialized knowledge. On numerous occasions negative effects were witnessed because of this lack of training in the field, as people who are not trained in pipe work, have recklessly attempt to perform installations that they know little about – and sometimes with disastrous consequences.

In 1998, four sailors died on board the Westralia Naval Frigate in Western Australia due to a fire caused by faulty fuel piping. From O'Reilly's perspective she suggests that had professionally trained pipe fitters been employed by the navy for that particular assignment, there would have been very different considerations and professional assessments carried out prior to that line's installation and modification. Potential problems and design faults would then have been identified and rectified before such a tragedy ever could have occurred.

"In analyzing the reasons for the substitution of such unassessed hoses for metal pipes in such a dangerous location, it became apparent that this ultimate error occurred from a series of mistakes made by a number of persons, as well as a number of systematic deficiencies. It seems obvious that if one person had a basic understanding of what was happening and had addressed the issues involved in a reasonable manner the disaster would have been avoided."

WA State Coroner, Alastair Neil Hope¹

¹ From the Record Of Investigation Into Death, HMAS Westralia Coroner's Report 2003 P.28 Investigation into the deaths of Shaun Damian Smith, Phillip John Carroll, Megan Anne Pelly and Bradley John Meek on the 5th May 1998 who died onboard the HMAS Westralia as a result of a fire caused by faulty fuel pipe modifications.

3.2 Present skills deficiencies

There is currently no available training for metal engineering tradespeople to learn pipefitting skills in the areas of:

- pipe safety
- pipe metals (varieties, properties & workability)
- pipe welding (with some exceptions)
- food grade pipe welding
- pipe weld contamination and prevention
- pipe joining and fitting methods
- use of specialised pipe trade tools
- nominal bores and other standard measurements
- reading pipe charts, technical drawings and blueprints
- knowledge of different fittings and their properties such as: valves; flanges; threads; seamed/seamless pipe; couplings; gaskets; elbows; T's; reducers; flange bolts; pipe brackets; offsets; thermal expansion etc
- constructing pressure-piping systems
- negotiating piping design factors
- pipe maintenance
- pipe installation.

The trade of *Pipefitting* embodies all of these skills deficiencies. This Fellowship report concentrates on the deficiency of an entire engineering trade rather than on the myriad of individual skills sets embodied within the trade of Pipefitting itself.

By visiting countries such as the USA and Canada, O'Reilly has acquired an understanding of the methods that technical training centres and industries utilise to accommodate the Pipefitting trade. Through traveling and networking with relevant people and organisations overseas, ongoing professional working relationships were established so as to assist local training colleges and industry access best practice trade skills knowledge in this area.

3.3 Specific trade skills gaps

- **Knowledge of pipe fabrication techniques:** includes math calculations and finding measurements on site locations; cutting elbows to desired angles; calculating offsets; weld gaps; shrinkage & expansion; rules for flange location; finding the size of an in-use pipe; using tools such as levels, plumb bobs and specialist tools for pipe work; using pipe stands; purging; bungs; steaming; acid wash; reading and making hand drawn isometric drawings; technical drawing symbols; other pipe related communication techniques, etc.
- **Pipe design considerations:** includes joining methods; metal and weld filler metal selection; location and environmental factors such as moisture, salt, heat and cold; flammable and corrosive substances in area; minimizing material usage; pipe fall or *piping offset*; fittings and radius length calculations; lagging; surface paints and coatings; 'dead-legs'; height; locating flanges, valves, strainers and gauge locations; ease of installation such as use of Elevated Work Platforms (EWP's) and evaluating the number of sections for ease of installation; negotiating locational considerations e.g. installation

around existing machinery and other obstacles as well as negotiating accessibility issues such as location of valves and couplings for maintenance and emergency shut-off, etc.

- **Knowledge of pipe installation and repair techniques:** including manual handling; use of ropes & knots; scaffold; rigging; EWPs; purging tools & techniques e.g.: bungs and dissolvable rice paper; fitting field-weld joints using angle iron, podgy bar, ropes and spirit levels; pipe supports and bracket placement; pipe *hammer*; air pockets; testing for leaks; hot tapping; pigging; patches; welded couplings, etc.
- **Knowledge of pipe safety:** including eliminating risk of contamination in food lines through fit, purge, weld techniques and pre & post weld buffing and machining; testing lines e.g.: non-destructive pipe testing techniques; safety regarding fuel and pressure pipes including design, construction, location, leak detection and environmental considerations; pressure vessel fabrication certification; welding qualifications; knowledge and application of relevant Australian Standards; pipe corrosion; pipe cracks; pipe modifications e.g.: removing; cutting into or destroying existing pipe lines and piping, installing new pipes, maintaining old pipes, etc.

Australian Manufacturing Workers Union Skilled Trades Committee

On the 27th April 2006, the Australian Manufacturers Workers Union Skilled Trades Committee invited O'Reilly to speak at one of their meetings about pipefitting skills deficiencies in Australia as well as the value of awards and acknowledgements for skilled tradespeople, such as those provided by the ISS Fellowship program. Her presentation for this meeting is included in this report. (See Appendix 1)

4. Findings I: Training for Pipefitters

O'Reilly visited the following North American sites in order to look at *pipefitting best practice* and to benchmark where Australian industry is at present. She attended conferences, training centres and industrial sites to gain knowledge of the trade, the methods utilised to train tradespeople in pipefitting and the pipe-trade industry's requirements of their tradespeople in North America. An investigation of design and creative problem-solving techniques and knowledge utilised by pipefitting tradespeople was also undertaken.

4.1 Program Content

United Association of Journeymen Pipe Trades Convention

Paris Hotel Convention Centre, Las Vegas Nevada USA

Contact: UA LU 525 Coordinator, Mr. Philip Campbell

United Association Pipe Trades Training Centre, Local 525

Las Vegas Nevada USA

Contact: UA LU 525 Coordinator, Mr. Philip Campbell

Southland Industries, Industry Site Visit

4765 Cameron St. Las Vegas, Nevada 89103 USA

Contact: Managers, Mr. Dale Stubblefield and Mr. Armando Najarro
Pipe Trade Contracting firm.

Quality Mechanical Industry Site Visit

3175 Westwood Dr. Las Vegas Nevada 89109 USA

Contact: Manager, Mr. Dale Stubblefield
Pipe Trade Contracting firm.

United Association Instructors Training Program

Washtenaw Community College,
Ann Arbor Michigan USA.

Contact: Director of Training, Michael Arndt

St Joseph's Hospital Construction Site

Ann Arbor, Michigan USA

Contact: UA Business Manager, Mr. Bryce Mitchell
Pipe installation project on construction site.

Welding Technology Institute of Australia

Study Mission Industry visits Canada:

AMEC Dynamic Structures:	British Columbia
Canron Western Constructors:	British Columbia
United Association Training Centre LU 488	Vancouver
Vancouver Shipyards	Vancouver
Waiward Steel Constructors	Edmonton Alberta
Supreme Steel	Edmonton Alberta
United Association Training Centre LU 170	Edmonton
DMI	Ontario
Mariani Metal Fabricators	Ontario
Synchrude Canada Ltd	Fort McMurray Alberta

J. Oskam Steel Fabricators Ontario
DMI Canada Toronto
Canadian Welding Bureau Head Office Toronto

Contact: Canadian Welding Bureau.

International Institute of Welding Annual Assembly.

International Conference Centre Quebec, Canada.

Contact: IIW President, Mr Chris Smallbone

4.2 Observing US and Canadian Pipefitting training centres

The Fellowship provided a unique opportunity to travel overseas and observe the trade occupation of Pipefitting. As established previously, the trade of pipefitting exists in many parts of the world, but not here in Australia. Through the Fellowship, O'Reilly was fortunate to visit world-class pipe-trade training centres, construction sites, industry conferences and training programs across North America. This gave an overall understanding of the skills, systems and structures employed to maintain pipefitting trade occupations overseas – understandings of which could not possibly be acquired or appreciated by means other than meeting with the artisans and professionals directly involved. The Fellowship provided a very special opportunity to introduce Australia to the trade of pipefitting.

The following key points are based on information collected overseas during the Fellowship travels. The United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry (hereafter 'United Association' or 'UA') is the responsible body for pipefitting trade accreditation, training and employment in the USA and (most of) Canada. As a result, most of the findings are based on this organisation, its structures, its training and people. The United Association spends over \$100 million annually on training program efforts involving approximately 100,000 journeyworkers (tradespeople) and apprentices in over 400 training facilities at any given time. The United Association produces pipe trade workers of an extremely high caliber.

4.3 Definition of Pipefitting

O'Reilly has devised the following definition of a *Pipe Fitter* by collating information received from a great number of experts and trade professionals across North America: Pipe Fitter Journeyworkers; Pipe Fitter Apprentices; Company Owners and Managers; Pipefitting Training Coordinators; United Association Business Managers; Industry Specialists; Training Specialists; and Pipefitting Instructors.

A Pipe Fitter is a metal trades engineer that specialises in the heavy industrial fabrication and installation of metal piping systems. A Pipefitter (unlike a plumber) performs all pipe work related to industrial, mechanical, process, heating, ventilation, cooling, refinery and product piping systems.

4.4 The United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry

The United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry (hereafter, United Association or UA) builds and operates world-class 'centres for excellence' Pipe Trade Training Centres throughout the USA and Canada. These Training Centres provide best-practice comprehensive accredited training and life-long

trades upgrade training and qualifications for all United Association Pipe Trade workers such as apprentices, pipe fitters, welders, plumbers, heating ventilation and air conditioning (HVAC) technicians, steam fitters and sprinkler fitters.

The United Association performs functions that can be divided into three general categories: Training, Structure, and Welfare.

United Association Training

- provides cost-free *Life Long Learning* for all members
- operates approximately 400 pipe trade training centres throughout North America
- is presently developing Bachelor of Education training programs for pipe trade workers
- encourages women and people from disadvantaged groups to undertake apprenticeships²
- operates a Joint Apprentice and Training Committee (hereafter, JATC) made up of 50/50 contractor and labour representatives. Consultants to the JATC are teachers, training coordinators and state and federal UA representatives. JAC examination processes are approved by government
- provides Pipefitting apprentices with a 5 year apprenticeship
- develops and publishes trade training books and materials
- encourages people of all ages to complete apprenticeships. It is not unusual for adults 40+ to undertake Pipefitting apprenticeships
- is the only organisation to provide accredited Pipe Trade training in the USA
- spends over \$100 million annually on training program efforts
- has established an annual five-day/five year Trainer-Training program in Ann Arbor Michigan
- is presently involved with a Building and Construction Trades Department's initiative *Helmets to Hard Hats* campaign. This campaign recruits returned Military, National Guard, Reserve and Veteran soldiers into Pipe Trade (and construction industry) apprenticeships (See Appendix 2)
- provides pathway courses for Non-UA Pipe Fitters to acquire accreditation
- operates pre-apprenticeship program that pays 30% of a Journeyman's wage.

United Association Structure

The UA:

- presently has 330,000 members, 60% of whom are Pipe Fitters
- builds strong relationships with businesses
- depends on its good reputation to secure the Pipe Trade construction market. To uphold its reputation, the UA exercises a number of strict policies designed to 'weed out' those who may blemish it, such as drug users, truants, etc
- is funded by members dues that are approximately 2% of a Journeyman's gross wage
- is organised into **Locals** or **Local Unions** (LU).

United Association Welfare

Locals operate as pipe trade employment agencies (comparable to Labour Hire and Group Training Companies in Australia). Journeyworkers first notify their Local of their

² A number of trade-qualified women have gone on to become Pipe Trade Training Coordinators of UA Training Centres.

employment status and availability. The UA then matches available workers with industry requests for labour.

Members vote annually to determine the percentage of their wage that will fund their local training centres, pension funds, health and 401(k) (tax deferred savings) programs.

Locals operate a Medical Plan and Pension Fund for members.

4.5 The Pipefitting Apprenticeship

To become a qualified pipe fitter in the USA, a 5-year apprenticeship must be completed. In most states, pre-apprenticeship training is a compulsory prerequisite to receiving an apprenticeship. Also, pre-apprenticeship students are paid a wage to study.

United Association Pipefitting apprentices must:

- attend 246+ hours per year of Local trade centre training (performed outside normal working hours)
- attend 1500+ on-the-job training hours per year
- possess a valid driving license
- have graduated from secondary school (or equivalent)
- be selected by a Training Committee via an examination process
- be 18 years of age or over
- possess a natural aptitude for the trade
- be physically able to perform the work
- be of good moral character
- be genuinely interested in learning the trade
- be willing to comply with all terms and conditions of the UA
- comply with drug testing policy (See Appendix 3)
- pay dues of approximately US \$18.00 per month
- pass end-of-year exams to graduate onto the next level, or repeat the entire year.

A UA apprentice's wage schedule is progressively increased at intervals over the term of their 5-year apprenticeship. The pay rate is expressed as a percentage of a qualified journeyman's wage and varies slightly between regions according to the economies of the local areas. For example, Local 525 Las Vegas Nevada pays first year apprentices a starting rate of 45% of a qualified Journeyman's rate. After six months, this is increased to 50%, after 12 months to 55%, at 18 months 60%, etc. At UA Local 601 Milwaukee Wisconsin, a Journeyman's wage is US \$32.50/Hr. + Benefits = US \$45.60/Hr. A Pre-Apprentice's wage is at 30% or US \$9.75/Hr. + Benefits (a little less than a Journeyman). A 1st Year Apprentice 40%, 2nd Year Apprentice 55%, 3rd Year Apprentice 60%, 4th Year Apprentice 65%, and a 5th Year Apprentice 80%.

UA apprentices must complete end-of-year exams before graduating onto the next year level and pay bracket. To pass, apprentices must achieve a minimum *Grade Point Average* of 75% and receive exam scores of no less than 70%. The assessment criterion is of an extremely high standard and for this reason many apprenticeships take longer than 5 years to complete.

Pipefitting trade training varies slightly between Locals across North America. The following table illustrates the apprenticeship curriculum charter for UA Local 525 Training Centre. (See Appendix 4a)

Typical Pipefitting Apprenticeship Curriculum:

1 st Year Apprenticeship	Hours	2 nd Year Apprenticeship	Hrs	3 rd Year Apprenticeship	Hrs	4 th Year Apprenticeship	Hrs	5 th Year Apprenticeship	Hrs
Safety	10	Orientation	3	Orientation	3	Orientation	3	Orientation	3
CPR/First Aid	6	Drainage	60	Oxy-fuel cutting and welding	183	Refrigeration	108	Uniform Plumbing Code	111
Math	30	Water supply	60	Pipe welding layout	60	CFC Certification	18	Backflow Assembly Tester Certification	54
Orientation	3	Fixtures	42	On the Job	1500+	Steam Systems	60	Advanced Plan Reading & Related Drawing	45
Soldering & brazing	24								
Heritage	12	Gas Installation	39			Hydronic Systems	33	Independent Study	33
Job safety	32	Medical gas certification	42			Pumps	24	On the Job	1500+
Use & care of hand tools	24	On the Job	1500+			On the Job	1500+		
Trade math	46								
Rigging	24								
Related science	24								
Blueprint & drawing reading	45								
Pipe & fitting recognition	12								
On the Job	1500+								

4.6 Joint Apprentice and Journeyman Training Committee

The Joint Apprentice and Journeyman Training Committee (hereafter, JATC) govern the employment selection of apprentices. The apprentice selection process includes an examination as well as interviews before the committee. These committees comprise (no less than) 3 employers and 3 UA members. As well as being responsible for indenturing pipe trade apprentices, the JATC: determine industry training needs; implement affirmative action and anti-discrimination plans and policies; review national standards; determine supplemental instruction; determine adequacy of employer's to provide adequate on-the-job training; establish a system for examination to determine the progress of apprentices; determine when an apprentice has satisfactorily met the requirements of his/her apprenticeship; are responsible for the successful operation of the UA training program; implement all necessary disciplinary action. (See Appendix 4a)

4.7 Instructors and Teaching Methods

Journeyworkers are recruited by UA Training Coordinators to become instructors. Although the Training Coordinator and Assistant Training Coordinator are full-time employees of the UA Locals, most trade instructors also hold down full-time pipe trade industry jobs as well as teach (after hours) for approximately 6 hours per week.

UA Training centres use *Time Based* (traditional *lock-step*) training methods (unlike Australia's *Competency Based Training* system).

The United Association develops and publishes its own Pipe Trade technical books, teaching guides and training unit modules. (See Appendix 4b)

4.8 Culture

There is a tremendous sense of pride and camaraderie between the members of UA Locals. This 'brotherhood' nurtures an environment of belonging that in turn, creates positive attitudes and minimises behavioural problems among students. Each Local has a number (E.g.: 525 Southern Nevada), and members display their Local's numbers with pride at every opportunity on: overalls; safety gear; toolboxes; hats; jackets; welding shields; tattoos; stubby holders etc. There is a real sense of 'team' that intensifies with participation at national events.



The UA's workshops are extremely well equipped with machines, tools and consumables as well as the latest technologies. There is no (or very little) tool pilfering, as students understand the privilege of their positions and are also aware that they *own* their Local; and as such do not steal from themselves.

Aside from the manual practicalities of the trade, it is also a requirement for all pipe trade students to learn about the history or heritage of their trade. This gives students some perspective regarding the importance of what they do as well as where they exist in an historical context.

All United Association employees, regardless of seniority (with the exception of some administration staff) are qualified journeyworkers.

Each Local designs unique pins that are traded and collected as souvenirs at national UA events such as Conventions and Instructor Training Programs. The UA has a culture of trading pins. Each UA Local designs a pin that represents their particular Local and State. e.g. The UA Local 120 Cleveland pin is shaped as a guitar, with the words *Home of Rock 'N' Roll*, and the UA Local 100 Dallas Texas pin is shaped as a sheriff's badge, etc. These pins are traded at UA national and interstate events and many members have collections comprising hundreds of pins. This culture of trading pins also fulfils a social purpose; for instance, to collect new pins, collectors must first introduce themselves to people from other Locals, giving them the opportunity to make new acquaintances.



Every year, over 2,000 Pipe Trade teachers from across North America attend a five-day United Association Instructors Training Program at Washtenaw Community College, Ann Arbor Michigan. The program has been held annually in Ann Arbor Michigan for the past 53 years. Each year, the town celebrates the arrival of the 2000+ pipe trade instructors, creating a festive atmosphere with welcoming posters, chalk boards and banners rigged from street lights throughout the town. The town also closes off the main street for one evening during the UA instructor-training week to hold a *Block party* with music and a Detroit classic car display. The Ann Arbor News *Entertainment & Hospitality Guide* features welcoming letters, special offers and gifts (such as Haab's pipe trade inspired stir-stick) for United Association members. (See Appendix16)

4.10 The Training Program

During the training program, pipe trade instructors participate in training courses designed to improve their teaching skills and upgrade their trade qualifications. Each participant of this program receives two hundred hours of instruction in total. Each participant receives forty hours of instructional training each year, over a period of five years. Also on offer are additional Post Graduate courses as well as other non-credit courses. (See Appendix 5).

The program is divided into two main elements of instruction: the Professional Element which involves courses dealing with the principles and techniques of teaching; and the Applied and Technical Element, which involves courses dealing with scientific and technical subject matter related to the pipe trades. This program offers 105+ different pipe trade related courses.

Purposes of the Program

The main purposes of the Instructor Training program are:

- increasing instructor's proficiency regarding training techniques and the use of United Association's instructional materials
- acquainting instructors with the philosophy and principles of education, especially trade, industrial and technical education
- providing learning experiences in the principles and the fundamentals of the applied knowledge subjects such as science, mathematics, drawing and electricity
- broadening and deepen the understanding of the instructors in the technical aspects of the crafts and bring information to the instructors about the latest developments in this area, as well as in the skills phase of the work of the UA Journeyworkers.

We believe that you, the instructors who teach the apprentices and journeyworkers of the piping trades, are the key persons in maintaining the high level of performance for which we have been long recognised. We are determined to retain our enviable position in this regard. Quality craftsmanship is an outcome of good teaching in our training programs³.



Pipe fabrication UA logo



*Specialised pipe welding equipment
Washtenaw Community College Michigan
August 2006*

Washtenaw Community College at Ann Arbor

Washtenaw Community College, Ann Arbor, Michigan is a technology based training facility in a tranquil parkland location that offers certificate and associate degree programs, seminars, workshops, and vocational education courses. The United Association operates a training unit at the college that coordinates the instructor-training program each year.

Washtenaw Community College also offers an associate degrees in *Construction Supervision*, *Industrial Training* and *Journeymen General Studies*: distance-learning programs designed for journeymen interested in becoming managers, foremen or running their own business. (See Appendix 6).

³ UA Instructor Training Program Brochure and Class Schedule 2006, P.6 (See Appendix 5)



Welding workshop, Washtenaw Community College Ann Arbor 2006



UA Instructor Training Program Rigging course, Washtenaw Community College Ann Arbor 2006

'Survival of the Fittest'

Participants of the 2006 United Association Instructor Training Program were welcomed at an *Orientation meeting for Apprentice and Journeymen Instructors and Staff* at Eastern Michigan University, presided by the UA Director of Training, Michael Arndt. The orientation concluded with an inspirational presentation by Mark Breslin about his recent book, *Survival of the Fittest*. The book was created to inspire and recruit journeyworkers and apprentices by means of communicating the importance of the work that they personally contribute to society. The book also delves into issues such as: attitudes and productivity; values and behaviour; being your best; apprenticeship and training issues; pride in heritage; teamwork, etc. The book is written in an informal way, but carries important messages about values as well as affirming trade workers sense of importance by recognising their social contributions. The book was originally written in answer to trade instructors concerns regarding generation Y's trend toward poor attitude and approach to work and training. As well as the book, Breslin has developed a series of teaching aids and training programs.

Pipe Trade Technologies at Ann Arbor

As part of the annual Instructor Training Program at Washtenaw Community College, businesses and organisations associated with the pipe trade industry are invited to attend, display their technologies and train instructors in the latest knowledge, standards and use of new welding and pipe trade equipment. These organisations include: American Welding Society (See Appendix 15); IAPMO (International Association of Plumbing and Mechanical Officials) (See Appendix 8); National Inspection Testing & Certification Corp; Miller (See Appendix 9); ESAB (See Appendix 10); Liburdi (See Appendix 11); Swagelok (See Appendix 12); Exel Orbital (See Appendix 13).



Andy Brunning,
Liburdi Automation Inc.
Washtenaw Community
College Ann Arbor 2006



Liburdi orbital welding machine, UA
Instructor Training Program Ann Arbor 2006



Liburdi Automation Inc.

Pipe Welding

The United Association is presently embarking on a *Welder Recruitment Program* in answer to the North American welding trade skills shortage. In 1997, the United Association joined with the Mechanical Contractors Association of America (MCAA) and the National Certified Pipe Welding Bureau (NCPWB) in order to offer a single uniform Welder Certification Program to the Mechanical Piping Industry. The Welder Certification Program exceeds the requirements of American Society of Mechanical Engineers (ASME) Section IX and ASME Piping Codes. Currently there are over 300 training schools and 170 Welder Certification Program (WCP) testing facilities throughout North America. Since the programs inception, the WCP has qualified over 16,000 welders. None of the costs associated with certification of welders is passed onto contractors or clients. The United Association provides for all the material and service costs associated with the qualification of welders. (See Appendix 14)

Also, the American Welding Society (AWS) offers a wide variety of American National Standards Institute (ANSI) standard and welding code training, study guides and pipe welding certification. The AWS has produced publications detailing regulations detailing specific pipe welding procedures including: austenitic chromium-nickel stainless steel piping and tubing; gas tungsten arc welding of titanium piping and tubing; gas shielded arc welding of aluminium and aluminium alloy pipe; welding of chromium-molybdenum steel piping and tubing; local heating of welds in piping and tubing; root pass welding of pipe without backing; guide for welding mild steel pipe; practical reference guide for welding inspection management – visual inspection of pressure vessels and pressure piping; safe practices for the preparation for welding and cutting of containers and piping; specifications for welding of austenitic stainless steel tube and pipe systems in sanitary (hygienic) applications; guide to weld discolouration levels on inside of austenitic stainless steel tube; specification for welding of tanks, vessels, and other equipment in sanitary (hygienic) applications. (See p.25 of Appendix 15)

United Association General President at Ann Arbor

On the 17th August 2006, United Association General President Bill Hite attended the UA Instructor Training Program in Ann Arbor Michigan. O'Reilly was fortunate to meet with President Hite where he explained to her big-picture visions for the UA. President Hite named priorities including: growing the membership; creating jobs; improving wages, benefits and

job opportunities; developing national accreditation programs. President Hite discussed the importance of training, and of how it has become the UA's "biggest asset". One of the UA's present focuses is on the *Helmets to Hardhats* campaign involving the recruitment of ex-military personnel into Pipe Trade occupations. (See Appendix 2)

Women Training Coordinators of the United Association

During the UA Instructor Training Program in Ann Arbor Michigan, O'Reilly was fortunate to meet with two distinguished female journeyworkers who are also Training Specialists as well as Training Coordinators for the UA training centres of their local districts.



Patricia Daniels Apprentice & Training Coordinator UA Local 601, Milwaukee and International Pipe Trades Joint Training Committee Member



Anne A. St. Elroi UA Special Representative, Washington DC

These women and the positions they hold within the association are testament to the professionalism and high standards of the UA as an organisation.

4.11 St. Joseph's Hospital Construction Site, Ann Arbor

On the 16th August 2006, an invitation was received from Bryce Mitchell of UA Local 190 Ann Arbor to visit the St. Joseph's Hospital construction site to view the pipefitting installations and meet with local pipe journeyworkers (tradespeople) and apprentices.



Specialised pipe fittings St. Joseph's Hospital Ann Arbor



Pipefitting installations St. Joseph's Hospital Ann Arbor



St. Joseph's Hospital pipefitting site construction

On site were pipefitting foreman and journeyworker Robert Fielder, and apprentices Andy Fielder and Brentley Richardson who showed O'Reilly around the site and discussed pipefitting construction, safety, training and installation. This site visit provided a special opportunity to meet with and observe the work of pipefitting professionals first hand.

4.12 Pipe Trade Training Centre Local 525 Southern Nevada

An invitation was received to visit The UA Training Centre Local 525 by Training Centre Coordinator Phil Campbell. This invitation provided an opportunity to see an impressive new complex, an outstanding example of a world-class educational facility. The building was purpose built as a joint collaboration project between instructors, students and an architect. As part of the building process, each instructor was allocated a classroom to design specifically to accommodate his or her own teaching methods. Also, as a Pipe Trade's training centre, the building was architecturally designed to display its pipe work (usually hidden away behind the walls and ceiling) through a clever use of Perspex walls, wire mesh grill (instead of a plaster ceiling) and mirrors articulated to reveal piping in awkward areas such as behind drinking fountains etc. Where possible, some functioning pipes were made out of transparent glass so that students can visually witness water flow and the physical transport of fluids along pipes for educational purposes (See Appendix 17).



UA Local Training Centre 525 Southern Nevada USA

Each classroom is equipped with digital teaching aids such as computers, overhead LCD projectors (two per room), DVD and Video equipment. Other non-digital teaching aids include large projection walls and white boards, drafting tables and fitting displays. Some theory rooms also incorporate provisions for practical work as well, such as workshop benches, tools and vices. All of the classrooms are large, clean, light and have been designed to accommodate classes of 20 students.

Other workshops have been designed for practical pipe construction. Students are required to design and construct piping to specifications and then 'tie in' to an existing live pipe (or apparatus such as a pump, boiler or chiller unit) in order to test the constructed piping under working conditions, or 'load'.

Apprentices contributed to the facility by fabricating many of the architectural features such as stainless steel bathroom fittings; railings; outside walkways and shelters around the centre.

Annexed to the Pipe Trades Training Centre is a welding workshop where journeymen can also obtain pipe-welding qualifications. The welding booths are large and well equipped, each containing fume extractors, 4 inch angle grinder for cutting, 4 inch angle grinder for grinding, 9 inch angle grinder, MIG welding machine, MMAW machine, TIG machine, fuel cutting torch and accessories, hammers, clamps, wire brushes, vices, pipe-welding clamps, motorized turning devices, PPE, and welding consumables.

Local 525 also features:

- a 50,000 square foot, state of the art learning complex.
- highest technologies training for apprentices, journeymen and pre-apprentices
- experienced instructors
- teacher consoles with digital teaching aids: LCD projectors, computers and audio visual technologies
- some of the finest classrooms, shops and labs in the USA.
- 11 classroom areas
- expandable rooms capable of seating up to 40

- a Distance Learning Lab seating 60
- 13 shop and lab areas
- 2 computer labs
- 2 soldering and brazing labs
- an underground training area
- a backflow lab
- a medical gas hospital room training workshop
- a welding workshop with 30 weld stations
- a soldering and brazing lab with 16 stations
- a unique coupon brazing device



UA Local 525 apprentice-built pipe structure walkway

UA Local 525 Classrooms and Teaching aids



Sprinklerfitting teaching aid



Student welding bay



Pump training facilities



Exposed pipes and glass pipes to examine installation and flow of liquid



Chiller room installations



Phil Campbell in the medical gas welding workshop

4.13 United Association Convention, Las Vegas Nevada 2006

O'Reilly's arrival in Nevada coincided with the United Association's 37th Convention. This convention is held every five years for the purpose of electing the General Officers of the United Association. In August 2006, in front of an audience of thousands of pipe-trade journeyworkers at the Paris Hotel Convention Centre, Bill Hite was reelected as General President of the United Association.



UA 37th Convention Las Vegas 8th August 2006

4.14 Pipefitting in Las Vegas

Las Vegas has a thriving construction industry. There are many new hotels and casinos being built, and many more in the queue awaiting construction. Considering this, and the isolated location of the city (in the Nevada desert), there is the constant problem of finding enough skilled workers to complete building construction projects. As a result of this situation, the construction workers in this area are very well paid and never short of work. The journeyworkers in Las Vegas have a saying: “Vegas wasn’t built on winners”: but it would seem that the *real winners* are the qualified tradesmen of Las Vegas, as they earn more money building the casinos than any punter ever did gambling in them! Each casino construction attempts to ‘out-do’ the last in size, dazzle and fantasy in an effort to allure tourists. The outcome of this has resulted in some extraordinary feats of plumbing and pipe work, including a spectacular nightly water fountain display (located on the main street) choreographed to the music of Elvis Presley’s *Viva Las Vegas!* Phil Campbell from UA Training Centre 525 assisted with the development and pipe installation of this water show.

Phil Campbell arranged for O’Reilly and Craig Stevenson (on a scholarship) from Reid Kerr College Scotland to visit two Pipefitting companies while in Nevada: Southland Industries and Quality Mechanical.

Southland Industries, Las Vegas

Southland Industries is an established business that specialises in the design, development and installation of metal piping for hotel and casino developments. The company is managed by Dale ‘Stubby’ Stubblefield and is located in the industrial area of Las Vegas. Dale is also an instructor at the UA 525 Training Centre. The company is in the process of relocating to larger premises. The workshop consists of certain features unusual to Australian fabrication workshops. For example, an automatic plasma-cutting machine designed to rotate, cut and bevel pipe of various sizes ready for welding. The workshop also contains specialised equipment such as a pipe alignment tools that are inserted into the pipe and expanded for the purpose of perfectly aligning the pipes ready for fabrication, welding and fitting.

At the time of our visit, electricians were installing electrical outlets from the workshop floor at the point of machinery locations. These outlets are a clever safety feature for the purpose of avoiding common occupational health and safety risks associated with running electrical extension leads over vast expanses of workshop floor.



Electrician installing floor-mounted power outlets



Southland Industries new workshop Las Vegas

Another interesting safety feature, are small trolleys designed to carry pipefitting power tools, complete with their own electrical outlet manifold. These trolleys are designed to reduce the back strain of the pipe fitter and improve overall manual handling practices of the pipe fabrication process.

The workshop also features trolley mounted *Miller* dual spooled and dual torched Metal Inert Gas (hereafter, MIG) machines outfitted with special bracket mechanisms that have been designed to improve the MIG welding of pipes. These machines are spooled with the wires of a variety of metals. This feature removes the labour intensive and time consuming need of refitting the machine each time a different metal requires to be welded. Again, the special trolley mount improves the manual handling practices associated with the constant moving of heavy welding machinery.

Dale has also developed an impressive pipe fabrication drawing system designed to assist pipe fitters with fabrication developments and job requirements. These drawings are designed to improve communication (between engineer and journeyworker) during the building stage of a project.



Dual wire spooled MIG welding



Pipe roller manual handling at Southland Industries



Pipe fitter demonstrating plasma cutting machine cutting pipe at the Southland Industries.



Pipe aligning tool



Pipe Fitter's portable power tool stand



Dual wire spooled MIG welding unit



Dale Stubblefield explains the new Southland Industries pipe construction project to Craig Stevenson Nevada August 2006.



After inspecting the workshop, a tour of the boiler/chiller/sprinkler house of the South Coast Hotel was undertaken where Southland Industries has recently completed the outfitting of the system. This facilities house is an extremely impressive example of the quality, care and professionalism of the pipefitting journeyworkers that built and installed it.



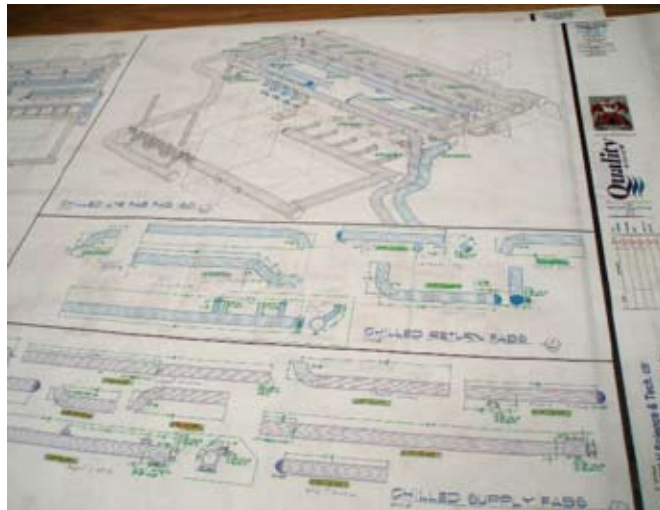
Southland Industry pipe installations at South Coast Hotel, Nevada



Southland Industry pipe installations at South Coast Hotel, Nevada

Quality Mechanical, Las Vegas

After the tour of the South Coast Hotel facilities house, a visit was made to inspect another pipefitting company also located in the industrial area of Las Vegas: Quality Mechanical. We were introduced to the many friendly pipe fitters and welders of Quality Mechanical who enthusiastically showed us their pipe work and the many features of the workshop.



'Quality Mechanical' pipe fitting drawings



4.15 Pipefitting in Canada

As part of the Fellowship study agenda, O'Reilly joined the Welding Technology Institute of Australia's Canadian Study Mission party in Vancouver on 19th August 2006. This study mission had pre-arranged invitations to tour many Canadian engineering businesses, many of whom employed pipefitters. Joining the WTIA study mission provided the opportunity to meet with many Canadian pipe fitters and to speak to them about their businesses, education and employment.

The WTIA Study Mission visited:

- The Canadian Welding Bureau, Toronto (See Appendix 18)
- J. Oskam, Toronto (See Appendix 19)

- Allied Shipbuilders, Vancouver (See Appendix 20)
- Syncrude (oil fields), Fort McMurray (See Appendix 21)
- AMEC Dynamic Structures, British Columbia (See Appendix 22)
- Canron Western Constructors, British Columbia (See Appendix 23)
- United Association Training Centre LU 488, Vancouver
- United Association Training Centre LU 170, Edmonton
- Waiward Steel Constructors, Edmonton Alberta
- Supreme Steel, Edmonton Alberta
- DMI, Ontario
- Mariani Metal Fabricators, Ontario
- The International Institute of Welding's Annual Assembly, Quebec. (See Appendix 24)

The study mission was on a very tight schedule, and as a result, these industry visits were generally very brief. Although brief, meetings were arranged with a number of pipefitting tradespeople and a great deal of information was communicated regarding the nature of the Canadian Pipefitting industry.

The Pipefitting trade education in Canada varies from the USA in that:

- Canada has both United Association training and technical colleges (TAFE equivalent) to provide Pipefitting training for apprentices. *Note: The training offered by the United Association is still considered to be the far superior option.*
- some Canadian UA Locals also utilise the facilities of the government established technical colleges to assist with their training
- Canadian Pipefitting apprentices have the option to complete a pre-apprenticeship course as well as a 4-year apprenticeship
- it is possible for a person who has not completed an apprenticeship (who has a great number of years experience in the pipefitting field) to apply for a nationally certified pipefitting qualification. There exists a national examination process for Canadian persons applying for pipefitting trade accreditation.



Allied Shipyards Vancouver.



*Brad Moe Allied Shipyards,
Chris Smallbone WTIA, Pat Newhouse
CWB.*



Mariani Metals Ltd, Toronto 2006



AMEC Dynamic Structures Ltd
Aluminium Telescope Vancouver
2006



Chris Smallbone with Pipe-trade Instructor Barry
Donaldson at UA Local 170 Vancouver 2006

Canadian Welding Bureau



Steve McQueen President CWB Group, Chris Smallbone President WTIA, Karen O'Reilly ISS, Marc Stone Manager CWB, James Lawrence WTIA, Ed Whalen General Manager CWB Learning Centre, Doug Luciani CEO Canadian Welding Bureau, Toronto August 2006

Syncrude Oil

One of the highlights of the WTIA study mission was a guided tour of the Syncrude shale oil fields and refinery of Fort McMurray Canada. Although the majority of Syncrude's pipe work is prefabricated and transported from Edmonton, the refinery itself stands as an impressive monument to the engineering skills of Canadian pipefitters and pipe welders. (See Appendix 21)



*Piping at Syncrude Oil Refinery Fort McMurray Canada 2006
Image courtesy Syncrude Canada Ltd.*

4.16 The International Institute of Welding, Québec 2006

The International Institute of Welding (hereafter IIW) was founded in 1948 for the purposes of promoting the development of welding, providing technical information on welding, assist the formulation of international standards and to promote the organisation of national welding associations. The IIW currently has 43 member countries, and the Welding Technology Institute of Australia (hereafter WTIA) is the Australian Representative body of the IIW. Mr Chris Smallbone is both the Executive Director of the WTIA and the President of the IIW.

The IIW conducts an Annual Assembly held in different countries every year. In 2006, the assembly was held in Québec Canada, and the WTIA study mission concluded in Québec to coincide with the start of the assembly.

The IIW Annual Assembly is divided into *commissions* and delegates participate in the commission working-group of most interest to them. (See Appendix 24)



Québec Conference Centre



International Institute of Welding President and WTIA Executive Director Chris Smallbone addressing the 56th Annual IIW Convention Québec 2006.



Chris Smallbone and Karen O'Reilly IIW Québec 2006

5. Findings II

Creativity, Design, Innovation and Problem Solving in Pipefitting

Author's note: As a qualified tradesperson and teacher, I am often surprised at the lack of understanding of the community in general surrounding the occupational requirements of engineering tradespeople – many people assume that our profession involves little more than mindless ‘production-line’ styled repetitive duties. For this reason, it is important here to clearly explain at least some of the qualities of a skilled and competent engineering tradesperson, in the hope that this will lay to rest some of the misconceptions surrounding the engineering trades and, hopefully, even inspire some evolutionary improvements to present trade vocational curriculum that is yet to incorporate methodologies designed for creative and innovative cognitive development.

“Creativity is the result of a disparate combination of elements not previously connected, therein original.” (ISS Institute, 2007)

5.1 Creativity and Problem Solving in Engineering

Part of this section is an excerpt taken from *Creativity in Engineering – Paradox and practice*, an essay by Karen O'Reilly 2007 (See attachment).

Creativity, design, innovation and problem solving are high-order skills of critical importance to all mechanical engineering tradespeople. In many respects, it is a difficult subject to broach as these skills, although heavily relied on in industry, are generally not verbalised nor taught as part of Australia's apprenticeship training package curriculum.

The level of knowledge acquisition required of a tradesperson in order to function as an ‘innovator’ and ‘problem solver’, is born (often) unconsciously out of necessity to perform at a very sophisticated level of proficiency. That level of deep understanding required in the first instance to obtain such high-order skills, can (presently) only be achieved as a result of many years ‘hands-on’ trade experience, a genuine interest in the trade, a sense of aesthetics, a personal drive to achieve one's best, as well as an ‘ownership’ of the task at hand. The ability to solve complex and abstract technical problems is the measure of a good tradesperson. A good tradesperson has capacity to exercise unique intelligences that incorporate all elements of the learning spectrum.

Engineering tradespeople in Australia who demonstrate exceptional creative problem solving abilities are often highly sought after by industry, yet are rarely rewarded either financially or in status for their efforts. In fact, often the best tradespeople are refused promotion because their employers are so reliant on the quality of their productivity.

Although tradespeople are required to perform structured, mechanical and mathematically based practical tasks, the cognitive methods utilised to solve complex conundrums, may at first appear to be of seemingly contradictory mindsets. As Einstein observed, “Problems cannot be solved at the same level of awareness that created them”.

As design, creativity, innovation and problem solving in engineering trades was a key component of the Fellowship program, O'Reilly sought an invitation to attend the Instructor Training Program of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada at Washtenaw Community College in Ann Arbor, Michigan. A pipefitter journeyworker is a metal trades engineer that specialises in the heavy industrial fabrication and installation of piping systems. Unlike a plumber, a pipe fitter performs all pipe work related to industrial, mechanical, process, heating, ventilation, cooling, refinery and product piping systems. Over the duration of the five-day training

program, many expert pipe fitters and pipe-trade engineering specialists from across North America generously shared their wealth of knowledge, experience and insight, assisting in the development of a detailed dataset concerning all aspects of the pipe trades - including creative problem solving.

5.2 Comments from North America on creative problem solving

Included here are some comments from expert journeyworker/tradespeople on the subject of creative problem solving in pipe trades.

The owner of the building and the engineer rely on our experience and expertise to install these systems correctly no matter how they are designed on paper. Our job is to ensure that the systems work. To do this we must be flexible in our installation process and take everything into consideration from jobsite logistics to how the maintenance of the system will operate when we are gone. Problem solving? That is our job, we are professionals.

(Phil Campbell, United Association Training Department Training Specialist, formerly UA LU 525 Training Coordinator, Southern Nevada)

Every year thousands of UA journeyman are training in the latest techniques and technologies, learning valuable skills and abilities that help make them expert craftsmen on a wide variety of projects and jobs; with problem solving being an integral part of this learning experience.

(Phil Martin, United Association Training Specialist and Technical Administrator of Certification Programs, Washington DC)

Working out complex piping issues in the field help to make almost all of our journeymen great problem solvers. '[They are] able to see multiple ways of completing the task at hand.'

(Robert Lamb II, United Association Business Manager LU 582, California)

[E]very day you work solving unique problems. That journeyman who wants to be the top guns in their trade looks for the latest tools that are available. They read every trade magazine they can get their hands on. They want to see what is out there that makes more sense for a proper installation. In all we have to develop a unique sense of problem solving to compete with our own ego of getting better. This trade is just like the game of golf. 'You cannot beat the game of golf, you can only get better.'

(Jaime V. Valdivia, Assistant Executive Director Piping Industry Progress & Education Trust Fund, California)

Those tasks that were performed (usually) under ideal condition in the training center do not always exist in the field. The experience a journeyman acquires in the field can often lead to a problem being resolved with little interruption in the project thus maintaining scheduling and cost estimates. When problems can be resolved yet the integrity of the plumbing system is kept, all those concerned benefit.

(Linden Raimier, International Association of Plumbing and Mechanical Officials (IAPMO), California)

Look how many times we are at a jobsite and the engineers have drawn up a print that is useless. This is because they have read what is supposed to be built, drawn the lines & symbols that are in the book, but they have never installed a system and do not understand the reality of installation ... They have a 2-D version of our trade rather than 3-D knowledge.

(Patricia Daniels: On 'Learning and the necessity for creative problem solving skills in Pipe Trades', Training Coordinator UA LU 601, Wisconsin)

(We) solve a lot of the problems...because of the lack of planning due to engineers, owners and general contractors. We...have to do our job and solve problems in a timely and cost effective way in order to cement our work and obtain a growing market share. The United Association of Plumbers, Pipefitters and Sprinklerfitters, perform this task of problem-solving better than any

trade. Union or non-union, we have the ability to know our systems and perform above and beyond to get the job done correct and on time.”

(Bradford Davis, Training Instructor UA LU 525 & Vice President of Pre-construction S3H Mechanical Construction, Nevada)

From this sample of quotes by leading pipe-trade educators, managers and technologists from North America, it is possible to gain a sense of the importance of problem-solving skills and their impact on employment and industry. The Journeyworker must be able to be innovative in their approach to his or her work, and solve problems at a very sophisticated level of proficiency in order to be considered competent in their vocation, thus ensuring the likelihood of securing future contracts. Such skills have a direct bearing on employment within a highly competitive construction industry market. The United Association considers training to be its biggest asset, and demonstrates this by focusing its enormous resources on developing and implementing world-class pipe-trade education for members. High-level trade problem solving skills secure the contracts, which in turn, secure journeyworkers livelihoods.

5.3 Educating Problem Solving and Innovative Engineering Skills in Australia

This section is an excerpt taken from *Creativity in Engineering – Paradox and practice*, an essay by Karen O'Reilly 2007 (See attachment).

[A] great deal of work in technology feels like art to those involved, even if it does not communicate expressively with other people as conventional artistic work is expected to do. It feels like art because it so regularly calls for aesthetic, quasi-intuitive judgments. (Arnold Pacey, *Meaning in Technology*, p.64, 1999)

Early technologists such as da Vinci, Kepler, Newton and Brunelleschi were attuned to the importance of aesthetic response and its relationship to problem solving and creative innovation. So too, we must not underestimate the importance of aesthetic satisfaction to engineering tradespeople, and its extraordinary power as a learning tool. Teaching methods designed to encourage aesthetic responses also generate feelings of empowerment and achievement for students, and consequently, the motivation necessary to become *innovative* trade engineers. Unfortunately, Australia's present competency based training system fails to acknowledge this in any capacity, and apprentices often develop a dislike for TAFE and learn to resent compulsory attendance training – mostly considering it to be a waste of time. As a result, many harbour negative associations with training, and this response negates the *aim* and *possibility* of creating intelligent, creative, innovative technologists for the future. In a globalised world of ever changing technologies, predicted consequences of skills shortages, and a future geared toward *innovation*, the focus of technology education needs to broaden and this should begin by acknowledging the importance of creativity to trade engineering. Permission for students to explore, inquire, discover, create and innovate is needed to operate in conjunction with skills based learning. This scenario would enhance trade education by: personalising the experience; generating meaning, motivation and interest for learning; instilling interest; heightening intelligence; and most importantly, providing opportunity for students to 'shine'.

In order to effect change, it is essential that *creative problem solving and innovation* learning and teaching methods to be introduced and incorporated into the vocational education of engineering tradespeople.

6. Recommendations

6.1 Options

- Educating tradespeople with Pipefitting skills and knowledge would reduce health and safety risks associated with an unskilled workforce designing and installing dangerous fuel pipes, high-pressure steam and bacteria-spreading food process piping. To resolve this situation, the trade of Pipefitting should be introduced into Australia
- Design Pipefitting trade accreditation in harmony with current international standards. International organisations such as IAPMO provide the global community with Pipe trade codes and standards, education and certification. Developing Australian Pipefitting training and qualifications against international standards would prepare Australian Pipefitting workers for a globalised economy
- Invite UA and IAPMO representatives to Australia to capitalize on their expertise of global Pipefitting industries and assist in the establishment of a Pipefitting trade curriculum and training facilities
- Introduce United Association styled Pipefitting Training Facilities into Australia that are operated and coordinated by trade professional educators to maximize efficiency. Specialised training facilities would assist educators to deliver world-class pipe-trade education
- Create pathways for Australian Metal Fabrication tradespeople to acquire Pipefitting trade accreditation. It would prove beneficial to develop a training program designed to bridge the knowledge gaps between the trades of Metal Fabrication and Pipefitting. Companies would then be granted a legitimate means through which to upgrade their employees trade skills
- Define pipe trade jurisdictional boundaries. At present, there is some confusion regarding Australian Piping jurisdictional boundaries. The trades of Plumbing, Gasfitting and Metal Fabrication presently accommodate 'overlapping' areas of skills expertise
- Establish an accredited pipe welding certification program designed to compliment Pipefitting trade requirements. Although there are presently a small number of nationally accredited pressure-pipe welding qualifications available for learning at TAFE, there is great potential for improvement. Certified welding programs could be designed to 'dovetail' a Pipefitting trade curriculum. This welding program would need to incorporate: Steam-pressure pipes; Food-grade stainless steel piping; Fuel and Petrochemical piping; Orbital pipeline; Cast and Exotic (specialised) pipe metals
- Participate in annual United Association Pipe-Trade *Trainer Training Programs*. As Australia does not have an equivalent training program, it would be extremely beneficial to establish a training arrangement with the United Association enabling Australian Pipefitting instructors to participate and update their knowledge and trade skills at the annual UA training program in Michigan USA. Participation in this program would strengthen international networks and ensure Australia's position as a leader in the field of Pipefitting
- Improve upon the present Vocational Training by incorporating teaching methodologies designed to acknowledge and enhance tradespeople's creative and innovative cognitive development into the proposed Pipefitting trade curriculum
- Address issues relating to career paths and lack of promotional opportunities for Pipe Fitters (and other) tradespeople, especially those whom excel in their trade. This could be achieved by developing skills benchmarking that rewards achievement with increased status, opportunity and financial benefits
- Establish a Pipefitting international exchange student program with the United

Association to accelerate Australia's acquisition of trade knowledge by learning from the world leaders in pipe trade training

- Appoint an Australian body responsible for maintaining global Pipe Trade networks and keeping abreast of new technologies that impact on Pipefitting
- At present, there is a large problem with students using illegal drugs at TAFE and there is also a growing problem of drug related violence in the classroom. This is an intolerable situation for teachers, especially considering their 'duty of care' responsibilities and lack of powers to deal with this situation at present. Workshops and drug/alcohol use are a lethal combination, and the TAFE bureaucracy is not equipped to deal with this situation and the immediate dangers. The United Association has a 'no-tolerance' attitude to drug use and implements its mandatory drug testing policy (See Appendix 3). In light of these occupational health and safety considerations, drug testing of students who use dangerous workshop/industrial machinery, should be considered a priority.
- In recognition of the effectiveness of the UA's Joint Apprentice and Journeyman Training Committee's apprentice selection process, the development of a Pipe-Trade specific standardized examination process could be developed by a team of trade educators, employers and professional associations as a recommended and endorsed tool for selecting suitable apprenticeship applicants
- The UA produces extremely talented tradespeople. The adoption of a similar yearly craft examination for apprentices would assist to improve the overall quality of the tradespeople that Australia is currently producing. Craft examinations would assert a *positive pressure* for apprentices to improve – especially if the consequence of failure was to mean repeating a year level, and remaining at the same pay bracket. All people require motivation to learn and the introduction of a craft examination would provide both students and teachers with a goal to strive for from year to year
- Develop strategies to encourage camaraderie between learners at trade training centres. Acknowledge (especially young) apprentice's desire to *belong* to a group and develop personal *identity*. Take measures to encourage group activities designed to improve moral, and in general, create an environment where apprentices *want* to be a part of, so as to maximize educator's capacity to achieve quality-learning outcomes. E.g.: Trade logo souvenirs and garments, trading pins, inter-campus events and competitions, scholarships, awards etc
- Establish a mentoring system to provide students with inspirational role models (further develop the ISS Institute Mentoring Program)
- Implement (like the UA,) the availability and delivery of life-long trade upgrade training
- Adopt strategies to encourage the recruitment of women and disadvantaged people into Pipefitting trades
- Develop a heritage unit of learning to instill students with a sense of place in Australian history and an acknowledgement of their importance in society
- Develop a publication comparable with Mark Breslin's 'Survival of the Fittest' book. This would help apprentices understand the importance of their work in society and improve work ethics
- Consider establishing an Australian branch of the United Association.

6.2 Recommendations

Based on the findings of this report as well as prior knowledge of the engineering and education industries in Australia, a list of recommendations has been assembled and divided into the categories of *Recommendations for*: Government; Industry and Businesses; Professional Associations; Education and Training; ISS Institute.

6.2.1 Recommendations for Government

In view of the findings, the Australian government is encouraged to:

1. Acknowledge the trade of Pipefitting as a skills deficiency and develop a nationally accredited trade-training program in harmony with current international training standards to rectify this deficiency. This training should ideally be developed with the assistance of United Association Training Specialists and Training Coordinators
2. Support the introduction of *problem-solving and creative innovation* units of study into the engineering trade curriculum as well as teaching methods designed to develop student's innovative potential
3. Create training pathways for Metal Fabrication tradespeople (working in the pipe trade field) to access *bridging* units of accredited Pipefitting training
4. Establish a nationally accredited pipe welding certification program to dovetail Pipefitting welding skills deficiencies. E.g.: *food-grade* stainless steel, *petrochemical* and *medical gas* pipe welding accreditation, etc
5. Finance training programs to *up-skill* trade teachers, enabling them to become competent Pipefitting teachers. E.g.: a trade skills exchange program with the United Association
6. Finance TAFE and Registered Training Organisations (hereafter RTO) to build pipe trade training facilities based on the Southern Nevada UA Local 525 model. E.g.: outfitted with trade specific training rooms, tools, machinery and pipe welding workshop facilities (See appendix 17)
7. Support professional and career opportunities and incentives for Pipefitters such as: awards; scholarships; fellowships; diploma and master courses; mentoring programs; access to *lifelong* trade upgrade training
8. Assist to establish an international exchange student program with the United Association to fast-track the introduction of Pipefitting trade skills into Australia
9. Develop strategies to encourage women and disadvantaged people into the Pipefitting trade
10. Support the introduction and development of a pipe trade *heritage* unit of learning
11. Develop an effective means for educators to deal with drug and alcohol-affected students in dangerous workshop environments. Also, consider introducing legislation to support drug testing in training workshops (See appendix 3)
12. Appoint a body responsible for maintaining global pipe-trade networks and keeping abreast of new technologies that impact on the Pipefitting industry
13. Support the introduction of yearly graded craft examinations for Pipefitting trade apprentices
14. Trial a Pipefitting pre-apprenticeship training program that pays a wage for students to attend.

6.2.2 Recommendations for Industry and Businesses

Although Pipefitting skills are absent from the Certificate III Metal Fabrication curriculum, industry has continued to demand workers with highly developed metal pipe fabrication, pipe welding skills and associated pipe trade knowledge. This absence of this training, impacts on Australian industries and businesses.

In view of the findings, Australian industry and business are encouraged to:

1. Support and assist with the development of a nationally accredited Pipefitting trade training program to be designed in harmony with current international standards
2. Support the introduction of *problem-solving and creative innovation* units of study into engineering trade training as well as complimentary teaching methods designed to develop student's innovative potential
3. Support the introduction of training pathways for Metal Fabrication tradespeople (working in the pipe trade field) to access *bridging* units of accredited Pipefitting trade training
4. Support a nationally accredited pipe welding certification program to dovetail Pipefitting welding skills deficiencies. E.g.: *food-grade* stainless steel, *petrochemical* and *medical gas* pipe welding accreditation, etc
5. Contribute to professional and career development opportunities and incentives for Pipe Fitters such as: awards; scholarships; fellowships; diploma and master course studies; mentoring programs
6. Develop strategies to encourage women into the Pipefitting trade
7. Develop strategies to encourage camaraderie and *pride* among Pipefitting tradespeople
8. Support and contribute to the establishment of pipe trade jurisdictional boundaries
9. Contribute to the development of a Pipefitting apprenticeship selection examination process to assist with appropriate selection of apprentices
10. Support a trial Pipefitting pre-apprenticeship training program that pays a small wage for selected students to attend
11. Support the introduction of yearly graded craft examinations for Pipefitting trade apprentices.

6.2.3 Recommendations for Professional Associations

The following organisations are key Australian bodies positioned to contribute to the establishment of the Pipefitting and pipe welding profession in Australia:

- Welding Technology Institute of Australia
- Australian Manufacturing Workers Union
- Australian Stainless Steel Development Association

In view of the findings, Professional Associations need to:

1. Encourage and assist with the introduction of nationally accredited Pipefitting trade training into Australia
2. Support the introduction of *problem-solving and creative innovation* units of study as well as teaching methods designed to develop student's innovative potential
3. Establish working relationships with relevant national and international organisations

such as the United Association, the International Institute of Welding and International Association of Plumbing and Mechanical Officials (IAPMO) etc

4. Assist with the establishment of Australian pipe trade jurisdictional boundaries
5. Assist with the development of a nationally accredited pipe welding certification program designed to dovetail Pipefitting welding skills deficiencies. E.g.: *food-grade stainless steel, petrochemical and medical gas* pipe welding, etc
6. Contribute to professional and career development opportunities and incentives for Pipefitters such as: awards; scholarships; fellowships; diploma and master course studies; mentoring programs
7. Assist with the development of a pipe trade heritage unit of learning
8. Develop strategies to encourage women into the Pipefitting trade
9. Create an easy-to-read handbook and teaching tools for Pipefitting apprentices to learn: trade expectations; values; sense of place and importance in society; pride in their trade. E.g.: Mark Breslin's *Survival of the fittest*
10. Develop strategies to encourage camaraderie and *pride* among Pipefitting tradespeople. E.g.: trading pins, participation in national and international pipe trade events
11. Contribute to the development of a Pipefitting apprenticeship selection process to assist with the appropriate selection of apprentices
12. Establish a body of representatives responsible for maintaining global pipe-trade networks to keep abreast of new technologies that impact on the pipefitting industry.

6.2.4 Recommendations for Education and Training Organisations

In view of the findings, the Australian Education and Training bodies are encouraged to:

1. Develop a nationally accredited Pipefitting trade-training program in harmony with current international training standards. This will require the creation of a new AQTF Code. I.e.: Certificate III Pipefitting Engineering. This would best be achieved by working in conjunction with United Association Training Specialists. O'Reilly is available to meet with the appropriate Industry Skills Council to input her findings and insights.
2. Introduce *problem-solving and creative innovation* units of study and as well as complimentary teaching methods designed to develop engineering student's innovative potential
3. Create training pathways for Metal Fabrication tradespeople (working in the pipe trade field) to access *bridging* units of accredited Pipefitting training
4. Introduce a nationally accredited pipe welding certification program (developed in conjunction with professional associations) to dovetail Pipefitting welding skills deficiencies
5. Finance training programs to *up-skill* trade teachers, enabling them to become competent Pipefitting teachers. E.g.: participation in the annual United Association Instructors Training Program Ann Arbor Michigan, as well as a trade skills exchange program with the United Association
6. Build pipe trade training facilities based on the Southern Nevada UA Local 525 model E.g.: outfitted with trade specific training rooms, tools, machinery and pipe welding workshop facilities
7. Contribute to the development of a Pipefitting apprenticeship selection process to assist with the appropriate selection of apprentices

8. Develop professional training opportunities and incentives for Pipe Fitters such as: awards; scholarships; fellowships; diploma and master courses; mentoring programs; access to *lifelong* trade upgrade training
9. Establish an international exchange student program with the United Association to fast-track the learning of Pipefitting trade skills into Australia
10. Develop strategies to encourage women and disadvantaged people into the Pipefitting trade
11. Develop a pipe trade *heritage* unit of learning
12. Develop an effective means for educators to deal with drug and alcohol-affected students in dangerous workshop environments
13. Establish and maintain global pipe-trade networks to keep abreast of new technologies that impact on the Pipefitting industry
14. Trial a Pipefitting pre-apprenticeship training program that pays a small wage for selected students to attend.
15. Develop and implement a marketing campaign that profiles the nature and scope of the work in this industry and the importance of it in its contribution to Australia's economy.
16. Identify and celebrate the 'masters' of the industry and profile them as inspirational 'heroes' for young people entering the trade.

6.2.5 Recommendations for the International Specialised Skills Institute

In view of the findings, it would be valuable if the ISS Institute would work alongside government, educational bodies, professional associations and industry in order to:

1. Assist with the development and implementation of a nationally accredited Pipefitting trade curriculum
2. Assist with the development and implementation of a *problem-solving and creative innovation* unit of study into the engineering curriculum for the purpose of improving student's innovative potential
3. Contribute to professional and career development opportunities and incentives for Pipe Fitters and apprentices such as: awards; scholarships; fellowships; diploma and master course studies; mentoring programs
4. Develop strategies to encourage the recruitment of women into Pipefitting trades
5. Develop strategies to encourage camaraderie and *trade-proud* learners
6. Assist with the design and implementation of a generic Pipefitting apprenticeship selection process
7. Offer professional advice and assist in the establishment of an international exchange student program with the United Association, for the purpose of accelerating the learning of Pipefitting trade knowledge and skills into Australia.

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Attachments

Creativity in Trade Engineering – Paradox and Practice

By Karen O'Reilly

In an age where world leaders and economists proclaim *innovation* to be the way forward, it is time to reassess the importance of creativity and creative innovation as it relates to technological progress in engineering.

A Creative History

The Renaissance period of the 15th century was the 'beginning of the Modern Age'. It was a time of revitalised culture and great technological progress, as well as an era of artistic and scientific innovation as defined by its geniuses: Leonardo da Vinci, Michelangelo, Donatello and Brunelleschi. For historians of technology, the Renaissance is considered to be an especially significant era, and the "period in which there first emerged the restless, technical inventiveness that so strongly characterizes Western culture" (Pacey, 1992 p.58). The Renaissance is also synonymous with individualism.

Unlike occupations of today, it was not unusual for workers to encompass a great number of seemingly unrelated skills areas, such as Filippo Brunelleschi who combined his many talents to work as an artist, architect and engineer; and Leonardo da Vinci, renowned for his work as an artist, scientist, technologist and inventor. The quest for technical advancement, and creative innovation became in itself the defining factor that marked the end of the Middle Ages.

Until the 18th Century, alchemists were the scientists, technologists, innovators and the spiritual sages of world civilization. Alchemists worked with metals and believed that within the elements of nature lay the key to understanding divine knowledge and the mysteries of the universe itself. Notably, the physicist Sir Isaac Newton was equally famous for his work with alchemy as well as mathematics, optics, astronomy, natural philosophy, and the occult. It was Newton's interest in the occult and its explanation of *action at a distance* that aided and inspired him to develop his theory of gravity.

Johannes Kepler (1571 - 1630) worked as an astronomer/astrologer, mathematician, physicist, philosopher, science fiction writer and Pythagorean mystic. He incorporated religious arguments and reasoning into his work and held firm conviction that mathematical relationships were the key to understanding the makeup of the universe. Kepler discovered the *Laws of planetary motion*, and was the first to correctly assess the moon's influence over cyclic tidal patterns.

For many like Kepler, the neo-platonic world gave numbers and geometric shapes an esoteric significance and assigned intellectual credibility to the mathematicus (practitioner of astrology & astronomy). Throughout history, mathematicians have been said to harbour an affinity for the beauty of numerical structures and equations that many consider to reflect the "structure of the universe" (Pacey, 1999 p.29) and mathematicians are believed to respond to the artistry of numerical harmony in much the same way others may respond to a masterpiece such as the Mona Lisa.

In contrast to the work of the alchemists and visionaries such as Newton, Brunelleschi, Da Vinci and Kepler, technologists today assert their professional credibility by disassociating themselves from the artistry, emotion and spirituality of times past in favour of observations that deal purely with logic and dry factual evidence. "[W]hat cannot be legitimately quantified is not worth knowing" (Burns, 2002 p.56).

It is important to bear in mind that in an historical sense, this is a very recent division of pursuits: and a division that comes at a social price. Building on hard facts is noble, however, it is imperative to note that purely convergent processes are severely limiting when considered in the context of innovation and human endeavour. It would seem today, that if quest for knowledge cannot be boxed into neatly quantifiable packages, then it is not considered worthy of scientific merit nor further consideration, and this is indeed an extremely limiting premise on which to proceed into the 21st Century. Our Modern Age approach to science and technology seeks to remove the divergent from convergent and lateral from logic and over time, this 'truth' has infiltrated culture and coloured our general understanding of the world and ability to think *outside the square*. "What makes creativity different is that there are no natural units or measures of production. We can measure and describe the things we create, but, as with invention, the process of creation that goes on inside our heads is far more elusive" (PMSEIC, 2005 p.11).

What is creativity?

Until relatively recent times, the qualities of creativity had been viewed as the elite realm of geniuses, and revered with "an aura of exclusiveness" (Powell Jones, 1972 p.vii). Creativity as a word has now shed these early connotations, and is now generally utilised to describe 'originality' and 'uniqueness' of everything from high-art to corporate concepts. The word *creative* is not only a descriptive term for acts of creation, but also used to describe a person's creative capacity. Late 20th century research revealed that all people are born with creative potential, however, a person's ultimate creative ability is dependant on a variety of factors including: environment; education; permission (for 'fluid thinking'); and encouragement. Further research suggests that *personality* is a key-factor in determining an individual's *style* of creativity.

Concepts of creativity

In 1950, Joy Paul Guilford addressed the American Psychological Association with his now famous lecture that distinguished *convergent* (black & white) from *divergent* (creative) thinking as well as explaining the cognitive approach to understanding creativity as it relates to intelligence. In 1967 Edward De Bono popularized the generative phase of creative cognition by contrasting it against the 'vertical' reasoning of *logic*, and coining the term '*lateral thinking*'. It was not until the 1970's that the subject of creativity truly generated widespread interest among psychologists, as prior to this, the "intelligence-testing movement, with its objective measurement, held sway" (Burns, 2002 p.163). Today, creative cognition is popularly believed to involve two major processes: *generative and exploratory*. This model as proposed by Finke et al (1992), is known as *geneplore*. The *geneplore* is responsible for generating creative concepts that usually operate at levels below that of human consciousness.

This generative phase of *geneplore* "[I]s characterised by the tolerance of ambiguity, the ability to hold contradictory ideas simultaneously; the maintenance of flexible constructs and a preparedness to look far afield for potential solutions" (Stevenson, 2003 p.163). Since Guilford's address, many cognitive psychologists have attempted to distinguish the elements and major aspects of the creative thought process as well as the conditional factors deemed necessary to promote creative thinking and behaviour. Rhodes developed the *Four P's* model describing a series of concepts comprised of qualities and conditions believed necessary to foster creative cognition, including: Personal characteristics, creative Process, Product and environment (Press). Arguably, creativity in trade engineering is manifest in this example.

Johnson (1972) further developed the P model by proposing: Sensitivity to Problems, Originality, Ingenuity, Unusualness, Usefulness, Appropriateness and Intellectual leadership as essential qualities for the 'creative agent'. In 1995 Sternberg & Lubert offered their conceptual insights by proposing: intellectual ability, knowledge, personality, style of thinking, motivation and environment. Today, creativity is likely to be assessed against: "novelty, appropriateness, transformation and condensation" (Burns, 2002 p.163). Novelty is regarded as one of the necessary elements of the creative process. The word *novelty* is often used in cognitive literature to define the qualities of originality and unusualness. *Appropriateness* refers to the creation's suitability for purpose. *Transformation* describes a 'radical shift' in approach, and *Condensation* refers to a creation's "summary power...such that continued contemplation of it fails to exhaust its meanings and implications" (Burns, 2002 p.163).

Generally accepted as cognitive processes, are the stages of *incubation* and *illumination*. *Incubation* is a period of time necessary where the mind rests in order to process elements of information. This stage is then followed by *illumination*: the moment that the mind formulates novelty by uniting previously unrelated elements. This stage is often referred to as 'a flash of insight', or the 'eureka effect'. These processes help to explain a phenomenon associated with very creative people whom experience ideas and insights at extremely unlikely moments such as sleeping, traveling or bathing etc. (Perkins, 2000) Interestingly, Einstein believed that his own creative ability was a result of his capacity for *spatial reasoning* - an ability not generally associated with convergent professions such as science. Spatial reasoning skills are of paramount importance to engineering professionals as their vocation depends on an acute ability to think, construct and reason in three dimensions.

Defining creativity

There is believed to be at least 60 different definitions of *creativity* published in cognitive literature. True to form, this does not deter the logicians of the world from trying to define creativity by applying logical explanations for a thought system that essentially defies logic. "Cognitive literature proposes a hierarchical structure of knowledge" (Stevenson, 2003 p.159), so the very foundations of such a structure would appear extremely incompatible with the makeup of any truly credible scientific definition. In the words of Earl Hunt on creative problem solving: "[It] is a bit like beauty, morality and good art. We are in favor of it, we know it when we see it, but we cannot define it" (Sternberg, 1994 p.215). In 1961 Rhodes attempted to identify one unifying definition. Although unsuccessful, he did observe that most existing definitions of creativity in fact "overlap and intertwine" (Rhodes, 1961 p.307) and for this reason, Isaksen suggests that researchers of creativity "tolerate a certain degree of ambiguity" (Puccio, 1999).

Khatena and Torrence (1973) proposed a useful definition of creativity: "[T]he power of the imagination to break away from perceptual set so as to restructure anew ideas, thoughts, and feelings into novel and meaningful associative bonds" (Fabian, 1990 p.16).

In the interests of clarity and continuity in light of the Department of Education, Science and Training's 2005 National ISS Institute Overseas Pipefitting Fellowship report, this paper will adopt the International Specialised Skills Institute's definition:

Creativity is the result from a disparate combination of elements not previously connected, therein original.

ISS Institute 2007

Making the link

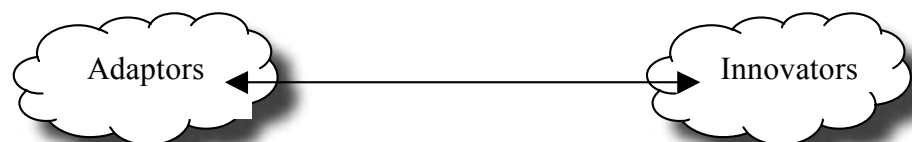
Kirton asserts creativity to be “a subset of problem solving” (Kirton, 2003 p. 8) and that “...creativity, problem solving and decision making are closely related, even to the point where it becomes difficult to make a sharp distinction as to whether they are different words for the same thing or interrelated facets of the same cognitive operation underpinning the generation and resolution of novelty” (Kirton, 2003 p.136). He goes on to discuss the many scientific definitions of creativity and problem solving and their tendency to overlap so significantly “that we are surely better off using the problem-solving concept for the purpose of research and assessment” (Kirton, 2003 p.141). On the subject of breakthrough thinking, David Perkins interestingly suggests that the act of “problem finding makes up a significant part of creativity” (Perkins, 2000 p.150). “Creative thinking produces novel outcomes, and problem solving involves producing a new response to a new situation, which is a novel outcome” (Guilford, 1977 p.161).

Guilford, Kirton, De Bono and Perkins all identified a crucial cognitive link between the acts of problem solving and creativity - the significance of which will later be explored in the context of trade engineering and innovation.

Integral to this cognitive equation is the issue of intelligence. Many psychologists believe that intelligence is “the ability to learn” (Guilford, 1977 p.160), but this definition has proved to be too vague. Guilford has described intelligence as “a collection of abilities for processing information of different kinds in various ways” (Guilford, 1977 p.22). Lewis Terman, the inventor of the Stanford-Binet intelligence testing scale, believes intelligence to be “the ability to do abstract thinking” (Guilford, 1977 p.11). Robert Burns supports this idea by suggesting: “[C]reativity tests would be a better indication than intelligence tests of potential to solve problems, to be innovative and to operate autonomously and proactively” (Burns, 2002 p.166). Cognitive psychologists and educators alike have revealed important links between human creativity, innovation (an outcome of creativity), problem solving and the realms of human intelligence.

Kirton also hypothesized a model continuum of personalities that distinguishes *Adaptors* from *Innovators*: Adaptors prefer working within defined structures and are characterised by precision, reliability, efficiency, discipline and conformity; Innovators prefer to challenge structures and question customs, and are often regarded as undisciplined, impractical and complex.

Kirton’s Adaptation-Innovation (A-I) Continuum of Personalities



Kirton maintains that regardless of character or where one sits in context of the continuum, each person possesses creative potential and that the individual's personality will determine his or her style of creativity and problem solving. All styles of creativity are valuable, and past research has established that creative potential can be developed and improved through formal training (for example, Parnes & Noller 1972). At this juncture, innovation as a process should also be explored.

Creative innovation

“Creativity and imagination applied in a business context is innovation”⁴.

Innovation, as well as an outcome of creativity, is also a term utilised to describe the process of transition from creative invention into economic activity. In this context, innovation is dependent on “organizational, social, economic, marketing and other knowledge at the enterprise level” (Curtain, 2004 p.9).

It was during the Industrial Revolution that the British settled Australia. At that time Britain’s manufacturing strength “lay in its highly skilled artisans rather than in university-degreed engineers” (Dawe, 2004 p. 24). It was the masterful engineering capabilities of these pioneering tradespeople that physically built and consequently industrialized our nation. Given the nature of this history, it is not surprising that today, Australia is internationally renowned for its innovative individuals and has deservedly acquired its “reputation for ingenuity and invention” (PMSEIC, 2005 p.29).

Innovation economy

The creative imagination knows no divide between science and art. It seeks the unknown and it invents the future. Australia has deep wells of imagination, and they’re distributed right across its population. This imagination is a human resource whose creative potential has yet to be fully tapped and transformed into economic and social value for Australia. The timing has never been better for a major government initiative to help make us a creative and innovative nation (PMSEIC, 2005).

We are at a crossroads in history, and the ripples of globalisation are altering nations. Western world leaders discuss the changing nature of economies and their expectations for the way we will conduct business in the future. “To be globally competitive, Australia needs to formulate a comprehensive approach to fostering creativity” (PMSEIC, 2005). While the tide of Australia’s manufacturing economy recedes, the *Innovation Economy*, still in its infancy, is already preparing to reshape our nation’s identity. In light of these looming changes, it is now time to prepare for vocational expectations of the future. This is imperative as we need to begin reassessing the way we approach technology-based education and initiate steps to implement an appropriate skills set designed to “underpin the economic drive to innovation” (Dawe, 2004 p.49).

[T]he prominence and significance of skills sets around Innovation, Creativity and Design for employees and individuals and their growing importance to the economy and creative well-being of Australia, must now be recognised and supported by the training system, business and government as a priority (IBSA, 2006 p.14).

Creativity in trade engineering

Engineering trades people often encounter social ignorance surrounding the scope and nature of their occupations. Even today, many people harbour unfair stereotypes of blue-collar tradespeople as “bogans” (Tanner, 2006), whose professions involve little more than mindless ‘production-line’ styled repetitive duties. For this reason, it is important to clearly explain some of the qualities of a skilled and competent trades person in the hope that this may break down some of the common misconceptions surrounding engineering trades. Every day, engineering trades people are required (among other things) to find and fix faults, design functional parts, solve mechanical conundrums and invent ‘one-off’ mechanisms

⁴ Mark Welsh former CEO of General Electric (IBSA, 2006 p.1)

(i.e.: *novel outcomes*). To complete these tasks satisfactorily, engineering tradespeople must also take into consideration any number of practicalities, abstracts and variables such as: work environment; safety; functionality; cost; personal ability; physicality; time; machinery; access to equipment and materials etc, because this is what they are employed to do. A common misconception is that university trained engineers always design and provide the finished working drawings for trades people to work from. In my experience, the reality is that on the rare occasions that engineers *do* actually manage to provide workshop or site installation drawings, they are often flawed and require redesigning on the shop floor during the building process. Within this situation lays a paradox; Who indeed *engineers* the design?

The lateral cognitive methods utilised to solve engineering conundrums, may at first appear to be of seemingly contradictory mindsets, but practical problems do not always have logical solutions. As Einstein so beautifully observed, “Problems cannot be solved at the same level of awareness that created them”. The level of knowledge acquisition required of a tradesperson in order to function as an *innovator* and *problem solver*, is presently developed at the subconscious generative and exploratory (geneptore) level out of necessity to perform at a very high standard. The innovative tradesperson can (presently) only acquire such high-order skills as the result of a combination of qualities such as: extensive *hands-on* trade experience; a genuine interest in the trade; a personal sense of aesthetics; a gut-level drive to improve on one’s best; and an ‘ownership’ of the task at hand.

Knowing your place

There is a hierarchy, among engineering tradespeople in Australia. This hierarchy is unofficial, but exists everywhere there are engineering trades: from maintenance departments through to building sites. It starts with the first year apprentice, and ends with the most skilled and experienced tradesman on the job. It is a pecking order that is not necessarily reflective of income, but by the level of trade mastery one has reached in comparison to colleagues on the shop floor. On the job, one must be aware of their position in the ladder too, as there can be consequences for anyone stepping outside their place within this *unofficial chain of command*. On site, new starters are quickly inducted. The tradesman with the highest status can be immediately identified by the way others discuss his skills, abilities, qualifications and achievements. In the construction industry, a tradesman’s reputation always precedes him, as there are always many whom he has worked with previously on other building sites. This reputation is his right of passage and automatically secures his position in the hierarchy – even before arriving on site.

In my experience as a practitioner in this field, status must be earned and those tradesmen who have earned their reputations as masters of their craft possess a combination of unique qualities that sets them apart from the rest. Their trade is their identity, their trade is personal, their trade is a vehicle of personal expression and means to establish self worth in a physical and social sense. These tradespeople display a genuine devotion to their craft for highly personal reasons. These tradespeople possess a gut-level drive to be their best and take great pleasure in solving challenging mechanical problems and the successful completion of projects. “Constructive ideas give a person a sense of mastery, a sense of power” (Powell Jones, 1972 pp. 11-12). This sense of mastery provides the satisfaction and motivation “...intrinsic to solving the problem itself” (Guilford, 1977p.166).

In Europe, master tradespeople are treated in the same way as those who receive doctorates. They have an important status in the international community, but not in Australia. For far too long we have downplayed the importance of apprenticeships. I think we need a system that elevates the status in society of a master artisan to that of

someone with a doctorate. There is interestingly an organisation in Australia, the International Specialised Skills Institute, under the patronage of Sir James Gobbo, that is striving to do this⁵.

Engineering trades people in Australia who demonstrate these kinds of exceptional abilities are often highly sought after by industry, yet are rarely rewarded either financially or in official status for their efforts. Australia's present manufacturing and construction industry structure lacks career advancement opportunities for skilled artisans, and is an area in need of systemic restructuring if we are truly to encourage skills development and the progress of technological innovation in engineering fields – and good people into trade engineering. Andrew Robb, the recently appointed Minister for Vocational and Further Education, has already expressed his support for “[H]igh-level trades qualifications, from a diploma through to the level of master artisan, based on the European approach to trades training” (Morris, 2007).

Creative engineering

Creativity, design, innovation and problem solving are high-order skills of critical importance to all engineering tradespeople. In many respects, it is a difficult subject to broach as these skills, although heavily relied on in industry, have not formally been recognised by institutions as a critical element of trade engineering, nor a *skills deficiency*. In an effort to “reframe” (Lakoff, 2003 p. xv) the present lack of institutional acknowledgement regarding the existence of innovation and creative problem solving within the engineering trades, it has become necessary to establish a new term of reference to rectify this deficiency.

Creative engineering is the difference between a useless blueprint and a trade worker's ability to make that system functional. *Creative engineering* is the ability of the journeyworker to materialize one-off functional mechanical objects from nothing more than a client's verbal concept. *Creative engineering* is the artisan's ability to apply unstated tacit knowledge such as subtle design features that improve in-use safety. *Creative engineering* is the tradesperson's ability to design and build jigs, tools, devices and other systems necessary to support the manufacture of engineered parts. *Creative engineering* is the ability to problem find and problem solve utilizing only the equipment available on-hand. *Creative engineering* is that area between doubting whether an engineering feat is possible, and *making* it possible. *Creative engineering* is the ability to implement the qualities of *novelty, appropriateness, transformation and condensation* to solve engineering conundrums and creating innovative solutions.

Teaching trades

The Australian Government is committed to the future prosperity of our nation and to fostering and improving our record of innovation. It is only through a world-class education and skills development system, and access to the best ideas and technology in the world, that we can grow our economic prosperity and nurture the capacity of our people to innovate and to develop new ideas⁶.

It is an unfortunate reality that Competency Based Training (the teaching method currently utilised to teach engineering apprentices) is not designed to acknowledge and accommodate the cognitive development of innovative thinking and creative problem solving that is so heavily relied on in trade engineering fields. Australia's competency based system, with its stripped to the bone, tick-box, competent /not-competent frame of referencing, is

⁵ Gary Hardgrave, former Minister for Vocational and Technical Education, 2006.

⁶ John Howard, Backing Australia's Ability: The Australian Government's Innovation Report 2005-2006

not a teaching method equipped to cope with the introduction of pedagogies designed to enhance creative innovation into the curriculum. Technical and Further Education engineering subjects receive funding to deliver “standard skills to large numbers at low cost” (Curtain, 2004 p.34) and “needs new freedoms to innovate, to be flexible enough to move with the rapid changes in industry” (DET, 2002 p.6). TAFE is not presently structured or funded to lucidly adjust to changing priorities. Building an educational environment designed to *nurture the capacity of our people to innovate* is indeed possible, but it requires a major shift from the old monkey-see monkey-do approach and we must learn to let go of an institutional culture that strives to measure, quantify and validate every action in the interests of progress. “[T]he diffusion of an Australian culture of creativity and innovation is being impeded by structural and intellectual silos in our educational system” (PMSEIC, 2005 p. 26).

Interestingly, 1994 saw the publishing of Anderson and Sosniaks’ ‘Forty-year retrospective’ review of Bloom’s Taxonomy of educational objectives, that revised Bloom’s original hierarchy of learning. This revised model built onto the original and replaced *evaluation* (as the previous highest level of learning), with *creation*. A good tradesperson has capacity to exercise unique intelligences that incorporate all elements of the learning spectrum including *synthesizing* (constituting “a pattern or structure not clearly there before” {Anderson & Sosniak, 1994 p.23}) and creativity. The opportunity to apply all aspects of Anderson and Sosniak’s revised version of Bloom’s taxonomy, as well as devise appropriate pedagogies pertaining to this task should be considered a priority for all curriculum developers of Australian vocational education – especially in light of the looming innovation economy. “[T]he skills required to support innovation need to have a solid theoretical basis to engage in problem-solving” (Dawe, 2004 p.49).

The ISS Fellowship

In August 2006, as recipient of the Department of Education, Science and Training sponsored 2005 National ISS Institute Fellowship to “undertake an overseas study program to gain a comprehensive understanding in Pipefitting, design, creativity, innovation and problem solving in engineering trades”, I was invited to attend the Instructor Training Program of the *United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada* at Washtenaw Community College in Ann Arbor, Michigan.

A Pipe Fitter Journeyworker is a metal trades engineer that specialises in the heavy industrial fabrication and installation of piping systems. Unlike a Plumber, a pipefitter performs all pipe work related to industrial, mechanical, process, heating, ventilation, cooling, refinery and product piping systems. Over the duration of the five-day training program, many expert pipe fitters and pipe-trade engineering specialists from across North America generously shared their wealth of knowledge, experience and insight, assisting in the development of a detailed dataset concerning all aspects of the Pipe trades - including creative problem solving. The following quotes are from the fellowship dataset collected at that time.

The owner of the building and the engineer rely on our experience and expertise to install these systems correctly no matter how they are designed on paper. Our job is to ensure that the systems work. To do this we must be flexible in our installation process and take everything into consideration from jobsite logistics to how the maintenance of the system will operate when we are gone. Problem solving? That is our job, we are professionals.

United Association Training Department Training Specialist, Nevada.

Every year thousands of UA journeyman are training in the latest techniques and technologies, learning valuable skills and abilities that help make them expert craftsmen

on a wide variety of projects and jobs; with problem solving being an integral part of this learning experience.

United Association Training Specialist and Technical Administrator, Washington DC.

Working out complex piping issues in the field help to make almost all of our journeymen great problem solvers. [They are] Able to see multiple ways of completing the task at hand.

United Association Business Manager, California.

[E]very day you work solving unique problems. That journeyman who wants to be the top guns in their trade looks for the latest tools that are available. They read every trade magazine they can get their hands on. They want to see what is out there that makes more sense for a proper installation. In all we have to develop a unique sense of problem solving to compete with our own ego of getting better. This trade is just like the game of golf. You cannot beat the game of golf, you can only get better.

Director Piping Industry Progress & Education Trust Fund, California.

Those tasks that were performed (usually) under ideal condition in the training center do not always exist in the field. The experience a journeyman acquires in the field can often lead to a problem being resolved with little interruption in the project thus maintaining scheduling and cost estimates. When problems can be resolved yet the integrity of the plumbing system is kept, all those concerned benefit.

Manager International Association of Plumbing and Mechanical Officials (IAPMO), California.

Look how many times we are at a jobsite and the engineers have drawn up a print that is useless. This is because they have read what is supposed to be built, drawn the lines and symbols that are in the book, but they have never installed a system and do not understand the reality of installation...They have a 2-D version of our trade rather than 3-D knowledge.

Pipe Trades Training Coordinator United Association, Wisconsin.

[W]e have to do our job and solve problems in a timely and cost effective way in order to cement our work and obtain a growing market share. The United Association of Plumbers, Pipefitters and Sprinklerfitters, perform this task of problem-solving better than any trade, union or non-union we have the ability to know our systems and perform above and beyond to get the job done correct and on time.

Pipefitting Training Instructor, Nevada.

From this sample of quotes by leading pipe-trade educators, managers and technologists from North America, it is possible to gain a sense of the importance of problem-solving skills and their impact on employment and industry. The journeyworker must be able to be innovative in their approach to his or her work, and solve problems at a very sophisticated level of proficiency in order to be considered competent in their vocation, thus ensuring the likelihood of securing future contracts. Therefore, such skills have a direct bearing on employment within a highly competitive construction industry market.

The United Association considers *training* to be its biggest asset, and demonstrates this by focusing its enormous resources on developing and implementing world-class pipe-trade education for members. High-level trade problem solving skills secure the contracts, that in turn secure livelihoods.

From Tradesperson to Master Artisan

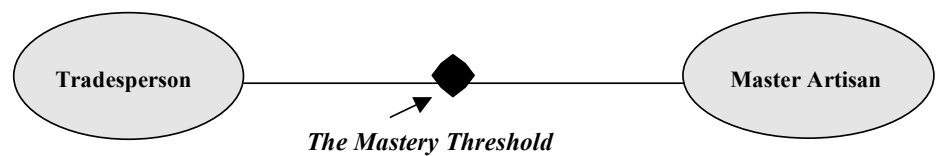
In Australia, we have been undervaluing the importance of our tradespeople's training and abilities for far too long. In all occupations there are people with varying levels of competence. At universities and business colleges around the world, white-collar academics strive to obtain degrees, and other tiers of accreditation that will ultimately catapult their careers

to positions of status and salaries they have *rightfully* attained. In (post apprenticeship) trade engineering occupations, there are presently no accredited benchmarks, no tiers, no degrees nor recognised levels or titles of attainment one can work toward in the hope of achieving a higher level of competency, status, position or wage. No mountains to climb, nor ability for career advancement within the occupation itself. If one compares the plethora of educational opportunities available to white-collar occupations, it serves to expose the institutionally perpetuated omission of career opportunities for blue-collar workers. “[T]he trades are educationally, economically and socially disadvantaged against those in professional disciplines”(ISS Institute, 2006).

These lack of career opportunities reinforce negative social perceptions – social perceptions that are now reflected by a serious skills shortage, and a generation's aversion to getting their hands dirty.

Regardless of status and institutional neglect, there does exist an unstated natural order between tradespeople, a tacit understanding built on respect according to experience, skills and knowledge of one's trade. This order can be expressed as a continuum: beginning with the newly qualified but inexperienced tradesperson, through to the level of *Master Artisan*.

Tradesperson –Master Artisan Continuum model



Tradesperson	Master Artisan
• can get through work life doing what they are told without much thought exertion or input • minimal craft knowledge • does not demonstrate capacity beyond minimum requirement • minimal capacity for problem solving • little concern for aesthetics • little capacity for innovation	• demonstrates exceptional intelligence • demonstrates independent problem solving capabilities • demonstrates passion for his or her craft • possesses great knowledge of craft skills • exhibits great capacity for design, creativity innovation • highly developed spatial reasoning abilities • exhibits qualities of <i>genius</i> • inventor • concerned with aesthetics as well as functionality • exhibits <i>ownership</i> of the task • gains a sense of achievement from work • craft integral to identity

This proposed continuum model represents a gauge from which we can begin comparing an individual's trade engineering ability against that of a Master Artisan. Although there are unquestionably tradespeople who do not exhibit qualities beyond the minimal requirement, the majority of experienced tradespeople would no doubt reside around the *Mastery Threshold* central region. Very few Australian tradespeople would presently qualify for Master Artisan status.

[A] great deal of work in technology feels like art to those involved, even if it does not communicate expressively with other people as conventional artistic work is expected to do. It feels like art because it so regularly calls for aesthetic, quasi-intuitive judgments (Pacey, p.64, 1999).

Early technologists such as da Vinci, Kepler, Newton and Brunelleschi were attuned to the importance of aesthetic response and its relationship to problem solving and creative innovation. So too, we must not underestimate the importance of aesthetic satisfaction to engineering tradespeople, and its extraordinary power as a learning tool.

The way forward

Pedagogies designed to encourage aesthetic responses also generate feelings of empowerment and achievement for students, and consequently, the motivation necessary to become innovative trade engineers. The present competency based system fails to acknowledge this in any capacity, and engineering apprentices often develop a dislike for TAFE and resent compulsory attendance training. As a result, many harbour negative associations with training, and this response negates the *aim* and *possibility* of creating intelligent, creative, innovative technologists for the future. In a globalised world of ever changing technologies, predicted consequences of skills shortages, and a future geared toward *innovation*, the focus of technology education needs to broaden and this should begin by acknowledging the importance of creativity to trade engineering. Permission for students to explore, inquire, discover, create and innovate is needed to operate in tandem with skills based learning. Add to this the (proposed) opportunity for engineering tradespeople to undertake a diploma-to-master artisan styled trade education that promises pathways for career advancement, the truly dedicated and innovative tradespeople will finally be given a forum to acquire the recognition and status they have long deserved. This scenario would enhance all tiers of trade education by: generating meaning, motivation and interest for learning; personalising the experience; heightening intelligence; nurturing the passion for inquisitive inventiveness; and most importantly, providing opportunity for engineering tradespeople to 'shine'.



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Appendix

1. AMWU Tele-conference 27 April 2006
2. Helmets to Hardhats campaign brochure
3. United Association Drug-free workplace policy and pamphlet
4. a) The Pipe Trades Joint Apprentice and Journeyman Training Committee for Southern Nevada Plumber/Pipefitter Curriculum 2006
b) United Association course outline and textbook document
5. United Association Instructor Training Program 2006
6. Washtenaw Community College and National Labor College degree courses for Journeymen
7. United Association Local 601 Steamfitter Training School course catalog 2005-2006
8. International Association of Plumbing and Mechanical Officials Official July/August 2006 publication
9. Miller catalog 2006
10. ESAB Welding catalogs
11. Liburdi Dimetrics Orbital Pipe Welding catalog and services
12. Swagelok Orbital Welding System products
13. Exel Orbital Systems operations manual
14. United Association Welder Certification Program
15. American Welding Society 2006 Catalog
16. Ann Arbor Michigan Hospitality Guide
17. UA Local 525 Training Centre PowerPoint presentation CD
18. Canadian Welding Bureau a) DVD b) CWA Journals August/September 2006 c) CWB Welding Certification publication d) CWB Red Seal Welder Upgrade Program documents
19. Oskam Steel Fabricators
20. Vancouver Allied Shipyards
21. Syncrude Fact Book
22. AMEC Dynamic Structures Ltd
23. Canron
24. International Institute of Welding a) Annual Report 2005 b) 59th Annual Assembly and International Conference of the IIW Circular No.2 c) IIW Vision and Membership document
25. Creativity in engineering – Paradox and practice (an essay by Karen O'Reilly 2007)
26. Media articles